No. 86-1917

Supreme Court, U.S.
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IN THE

Supreme Court of the United States

October Term, 1986

BARNES-HIND/HYDROCURVE, INC., and
BARNES-HIND INTERNATIONAL, INC.,

Petitioner,

vs.

BAUSCH & LOMB INCORPORATED,

Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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May 29, 1987

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100 pp

Questions Presented

The District Court, having heard three experts testify on behalf of plaintiff and one fact witness testify on behalf of defendant as to a key technical fact, dispositive of a critical issue, accepted defendant's version of the critical fact and held plaintiff's patent invalid for obviousness under 35 U.S.C. §103. In direct contravention of this Court's recent admonitions, the Federal Circuit disregarded the dispositive findings, without finding them clearly erroneous, and substituted its own factual determination based on the testimony of plaintiff's experts which had been rejected by the District Court.

1. In light of the foregoing: Did the Federal Circuit improperly disregard testimony accepted by the District Court, contrary to *Anderson* v. *Bessemer City*, 470 U.S. 564, 574 (1985), and Rule 52(a), Fed.R.Civ.P?

2. Did the Federal Circuit improperly make independent factual determination of a *Graham* subsidiary fact that the prior art taught away from the problem, contrary to *Dennison Manufacturing Co.* v. *Panduit Corp.*, 475 U.S. ——, 106 S.Ct. 1578, 89 L.Ed.2d 817 (1986) and Rule 52(a), Fed.R.Civ.P.?

3. Should the Federal Circuit's remand be summarily reversed where the findings of fact, not found to be clearly erroneous, establish obviousness and thus invalidity?

Concurrent Petition Having Closely Related Issues

The Court's attention is respectfully directed to the petition for a writ of certiorari to the United States Court of Appeals for the Federal Circuit naming Dennison Manufacturing Company as Petitioner in *Dennison Manufacturing Company* v. *Panduit Corporation,* No. 86 1700, filed on April 23, 1987. That petition presents closely related questions concerning the applicability of Rule 52(a) to the independent fact finding of the Federal Circuit in patent appeals concerning evidentiary considerations.

Dennison was before this Court previously, 475 U.S. ——, 89 L.Ed.2d 817, 822; 106 S.Ct. 1578 (1986), when certiorari was granted, and was remanded for the Federal Circuit to give its "informed opinion on the complex issue of the degree to which the obviousness determination is one of fact."

Statement Pursuant to Rule 21(b)

The caption of the case in this Court contains the names of the parties to the proceedings in the United States Court of Appeals for the Federal Circuit.

Statement Pursuant to Rule 28.1

Petitioner's corporate name has been changed to Barnes-Hind, Inc. and is a wholly owned subsidiary of Revlon, Inc.

TABLE OF CONTENTS

	PAGE
Questions Presented	I
Concurrent Petition Having Closely Related Issues	II
Statement Pursuant to Rule 21(b)	II
Statement Pursuant to Rule 28.1	II
Opinions Below	1
Jurisdiction	2
Statute and Rule Involved	2
Statement of the Case	3
Introduction	3
1. The Technology	4
Hard and Soft Toric Contact Lenses with Mechanical Markings	4
2. The Patent	4
3. The Prior Art	5
Brucker Patent	5
Caddell	5
Prior Use of a Laser System for Marking Plastic Materials (The LASERMARK System)	6
The District Court's Findings	6
a. Scope and Content of the Prior Art	7

PAGE

b. Difference of Claims Over Prior Art 7

c. Level of Skill in the Art 8

d. Obviousness Findings 8

The Trial Proceedings 8

e. Other Obviousness Indicia Were Ruled Upon 13

The Federal Circuit's Decision 14

Reasons for Granting Writ 14

Argument 15

Point I—The Federal Circuit should not have made its own subtest finding 15

Point II—The remand order was improper 17

Conclusion 18

Appendix:

Opinion of Federal Circuit Court of Appeals 1a

Judgment and Mandate 17a

Denial for Petition for Rehearing 18a

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J. 19a

Judgment Declaring Patent Invalid and Void 34a

PAGE

Trial Testimony, Excerpts of Plaintiff's Witnesses:

Robert D. Mandell 36a

William E. Thomson 40a

Ronald Salovey 41a

Trial Testimony, Excerpt of Defendant's Witness:

Richard Miller 42a

Plaintiff's Trial Exhibits:

Exh. 1; Fischer, et al. Patent No. 4,194,814 ..... 46a

Exh. 27; pp. 1, 17-19, Deposition of D. Brucker 55a

Exhibit 28; Caddell Patent No. 3,549,733 ..... 58a

Exhibit 29; Sales Brochure of Carco, Inc. 65a

Defendant's Trial Exhibit:

Exhibit 3, Brucker Patent No. 3,833,786 ..... 66a

Excerpt of Plaintiff's Proposed Findings of Fact and Conclusions of Law Under Local Rule 235-8, pp. 1, 21, 22 ..... 71a

Bausch & Lomb Reply Brief on Appeal to Federal Circuit, p. 22 ..... 74a

TABLE OF AUTHORITIES

PAGE

Anderson v. Bessemer City, 470 U.S. 564, 105 S.Ct. 1504, 84 L.Ed. 518 (1985) ..... i, 15, 16

Dennison Manufacturing Company, 475 U.S.——, 106 S.Ct. 1578, 89 L.Ed.2d 817 (1986) ..... i, ii, 15, 17

Graham v. John Deere Co., 383 U.S. 1, (1966) 6-7, 14, 17

Icicle Seafoods, Inc. v. Worthington, 475 U.S. ——, 106 S.Ct.——, 89 L.Ed.2d 739 (1986) 15

United States v. Adams, 383 U.S. 39 (1966) 17

Statutes and Rules:

28 U.S.C. § 1254(1) 2
35 U.S.C. § 103 ..... 2, 14
Rule 52(a), Fed.R.Civ.P. 2, 14, 15

No. 86-

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October Term, 1986

BARNES-HIND/HYDROCURVE, INC., and BARNES-HIND INTERNATIONAL, INC.,

Petitioner,

vs.

BAUSCH & LOMB INCORPORATED,

Respondent.

PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Petitioner Barnes-Hind-Hydrocurve, Inc. and Barnes-Hind International, Inc. (hereafter "Barnes-Hind") respectfully prays that a writ of certiorari issue to review the judgment of the United States Court of Appeals for the Federal Circuit in the above entitled cause of action.

Opinions Below

The opinion of the Federal Circuit (1a) is reported at 796 F.2d 443 (Fed.Cir 1986). Petition for rehearing was denied on March 10, 1987 (18a). The Findings of Fact and Conclusions of Law of the District Court following trial (19a) are reported at 226 U.S.P.Q. 780 (N.D. Cal. 1985) (no fed. cite).

Jurisdiction

The judgment of the Court of Appeals was entered on July 14, 1986 (17a) and rehearing was denied on March 10, 1987 (18a). This Court has jurisdiction pursuant to 28 U.S.C. §1254(1).

Statute and Rule Involved

35 U.S.C. §103 reads:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Rule 52(a), Fed.R.Civ.P. reads:

> *Findings by the Court.*
>
> (a) Effect. In all actions tried upon the facts without a jury or with an advisory jury, the court shall find the facts specially and state separately its conclusions of law thereon, and judgment shall be entered pursuant to Rule 58; and in granting or refusing interlocutory injunctions the court shall similarly set forth the findings of fact and conclusions of law which constitute the grounds of its action. Requests for findings are not necessary for purposes of review. Findings of fact, whether based on oral or documentary evidence, shall

not be set aside unless clearly erroneous, and due regard shall be given to the opportunity of the trial court to judge of the credibility of the witnesses * * *.

Statement of the Case

Introduction

Respondent, Bausch & Lomb Incorporated (hereafter "Bausch & Lomb"), filed this patent infringement action against Petitioner Barnes-Hind in the United States District Court for the Northern District of California. Bausch & Lomb charged Barnes-Hind with infringement of its patent No. 4,194,814, enitled "TRANSPARENT OPHTHALMIC LENS HAVING ENGRAVED SURFACE INDICIA," issued on May 25, 1980 to David J. Fischer, James A. McCandless and James D. Hager (hereinafter "the patent in suit" or "the '814 patent" (46a)) (F-5, 20a).* Claim 1, and dependent claims 2 and 7 are in issue (3a).

At the time of the patent application, the inventors were employed by a Florida company, Milton Roy Company, which manufactured soft contact lenses. The patent application for their invention was assigned to Milton Roy Company (F-8, 20a).

Bausch & Lomb, the present owner of the '814 patent, is a manufacturer of soft contact lenses and other optical products. It became the owner of the '814 patent as a result of its purchase, in 1979, of the soft contact lens manufacturing business of Milton Roy Company (F-9, 20a).

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* The Findings of Fact of the District Court will be referred to as (F-), followed by the Appendix reference.

Defendants, as well as a predecessor company of Barnes-Hind/Hydrocurve, Continuous Curve Contact Lenses, Inc., also are engaged in the business of manufacturing various types of contact lenses, including hard and soft lenses (F-10, 20a).

Barnes-Hind defended on the grounds that the patent was invalid for obviousness as defined by 35 U.S.C. §103 and that the claims were not infringed.

1. The Technology

Hard and Soft Toric Contact Lenses with Mechanical Markings

The technology relates to applying a mark to a piece of plastic material. The plastic is in the form of hard or soft contact lenses. Hard contact lenses became available to the public in the early 1950's and soft contact lenses in 1970, (F-14, F-15, 21a). Hard and soft "toric" lenses, i.e., lenses to correct for astigmatism, differ from conventional contact lenses in that they are thicker at the base portion of the lens (F-16, 21a).

In order for a toric lens to be properly prescribed for and fitting on an astigmatic eye, it is necessary that the fitter be able to locate and identify a central lens axis aligned with the prism base when the lens is placed on the cornea to determine the correct orientation of the lens on the eye. Markings on the lens surface greatly facilitate this fitting process (F-17, 21a).

2. The Patent

The patent in suit, filed in 1977 (46a), relates generally to a technique of marking a plastic contact lens by

using a conventional marking laser, whereas lenses had previously been marked by ink or by a mechanical tool.

The patented subject matter is set forth in the Federal Court of Appeals' opinion and the District Court's findings.

The trial proceeding focused on the expert and technical testimony as to whether a certain prior patent to a person named Caddell, filed in 1968 (Exh. 28, 58a), that disclosed etching of plastic by use of a laser rendered it obvious to etch a plastic lens by use of the same laser.

3. The Prior Art

Brucker Patent

The founder of Barnes-Hind, Dr. Donald Brucker, pioneered the use of a laser for etching small holes in a plastic contact lens, referred to as "fenestration" (F-19-21, 29, 39, 40, 50-52, 22a, 25a-27a). Laser etching produced holes which were smooth and polished and had rounded edges at both surfaces of the lenses (F-40, F-56, 25a, 27a); Brucker obtained a patent on his technique (66a).

Caddell

The Caddell patent disclosed the use of a laser to etch or remove plastic from the surface of a printing plate to form a pattern (F-27, F-28, 23a). Caddell taught that the laser could etch part-way through the plastic or completely through the plastic simply by varying the intensity of the laser beam (F-28, 23a). Since Caddell was producing a printing plate, it was important to his process that the etched depression be free of any ridges surrounding the depression.

He taught two ways of achieving a ridgeless depression; the first was to use a laser beam having a high enough

intensity to vaporize the material without melting it, and the second was to use a material such as Delrin which produced sharp edges when melted (F-46, 26a).

The Caddell patent also taught that when using a laser beam having an intensity sufficient to vaporize plastic material, some melting and therefore "rounding" of the edges would occur which is unsatisfactory in a printing plate but most desirable in a contact lens (F-47, 26a).

Prior Use of a Laser System for Marking Plastic Materials (The LASERMARK System)

In February 1976 the Production Manager of Milton Roy Company, Mr. James D. Hager (one of the patentees), saw an advertisement from a company called Lumonics who was in the business of laser marking a wide variety of materials and products, including plastics (F-61, 28a).

The advertisement (Ex. 29; 65a) refers to the LASERMARK system of Lumonics Laser Marking Div. and discloses that the process is applicable to "most plastics" and that marking is produced by vaporizing the material.

Inspired by this advertisement, Mr. Hager, on April 8, 1976, forwarded six (6) lenses to the Lumonics Company for marking. Lumonics marked those lenses and returned them to Mr. Hager (F-63, 28a). The lenses were satisfactory (F-64, 28a).

The District Court's Findings

As required by *Graham* v. *John Deere Co.*, 383 U.S. 1, 17-18 (1966), the District Court made the following *Graham* findings:

a. *Scope and Content of the Prior Art*

The scope and content of the prior art consisted of prior mechanical lens markings; Brucker's laser through-etching of contact lenses as disclosed by his Laser-Con process and his patent; Caddell's 1968 patent disclosing partial and through-etching; and Lumonics 1976 laser marking of plastic materials, all described above.

b. *Difference of Claims Over Prior Art*

The differences between the claims and the prior art were carefully considered. The District Court analyzed the proceedings in the Patent Office (F-26-38, 23a to 25a) and found that the claims were allowed because of the argument that Caddell disclosed non-cross linked material which tended to melt and form a ridge while the cross-linked material of the patent was vaporized without forming a ridge (F-32, 24a), and that the examiner allowed the claim because the prior art did not disclose "transparent cross-linked . . . having smooth surfaces of unsublimated polymer," that is, ridge-free (F-37, 24a).*

The District Court found that the claims of the patent were for a contact lens formed of a transparent cross-linked polymer material which included a mark on its surface made by a laser, and that the area contiguous to the mark was smooth and unaffected (F-22 and F-23, 22a).

---

* The technical words "sublimation" and "cross linked polymer" require a brief explanation: When a laser is used to vaporize a material directly from the solid to a vapor without going through the liquid state (i.e. melting), and therefore without leaving any melt residue, the process is called "sublimation." A "cross linked polymer" means a polymer chain of molecules "in a highly intertwined state" which "do not melt" and "do not dissolve" (41a). (Testimony of Bausch & Lomb's polymer chemist, Dr. Salovey).

The Federal Circuit stated that the District Court "disregarded express claim limitations," and yet characterized the claimed product almost identically as "an opthalmic lens formed of a transparent, cross-linked polymer and that the laser marks be surrounded by a smooth surface of unsublimated polymer." (13a).

c. *Level of Skill in the Art*

The District Court did not make any findings as to the level of skill of a person skilled in the art. The District Court had stated that the relevant area of technology included physiological optics, marking, and the prior art:

> "The Court: All right. There's two areas wherein I think you may require some further showing of expertise and that is in the area of marking and in the area of prior art. Now, in the area of smoothness, certainly in physiological optics he would be familiar with smoothness because necessarily he certainly would want to check for any rough edges on the cornea, but these other two areas, prior art and marking, I think you should elicit more expertise if any from him." (36a).

The level of skill had not been disputed by the parties and moreover is not germane to the issues presented here under Rule 52(a).

d. *Obviousness Findings*

The Trial Proceedings

The evidentiary phase of the trial covered four days. Bausch & Lomb presented three technical experts, one patent law expert and a fact witness. Petitioner presented one fact witness experienced with laser markings. The District Court listened carefully, referred to his "copious

notes" (45a), and had ample opportunity to weigh the expert testimony during and after cross examination.

The trial quickly narrowed to the basic factual issue as to the significance of the cross-linked plastic material used in the contact lenses. Bausch & Lomb expert, Dr. Mandell, admitted that in the prior art contact lens had been mechanically marked by a drill, and that lasers had been used to drill through a lens (36a).

> "Q. And wouldn't it be—have been the most obvious thing in the world to have taken the laser which has gone all the way through the lens to use it to go only partway through the lens as you did with the drill?
>
> A. [Dr. Mandell] If you knew a laser was capable of doing that.
>
> Q. And that was all that was missing in the equation to your knowledge, that a laser was capable of going partway. Is that correct, sir?
>
> A. I would say that's the most important thing, yes." (37a).

and

> "Q. Is it your testimony that if it was known to the skilled person that the depth of the laser could be controlled, then it would have been obvious to use the laser to mark the lens?
>
> A. If I had known that I could do that with the materials that were used for a contact lens, yes." (37a).

The Court thought this important.

> "The Court: Before you do that, let me take one of the answers and see if I could understand it.
>
> You are saying that had you had the knowledge that the laser beam could be controlled in such a manner

that you could regulate its depth of penetration into the lens for marking purposes, that it would then be obvious—

Mr. Calimafde: To use it.

The Court: —To use it.

The Witness: [Dr. Mandell] If I had known it would work on the material which is in the contact lens in that way.

The Court: Then it would be obvious to use this as another means of marking the lens?

The Witness: Yes." (37a-38a)

Dr. Mandell then made a key admission.

"Q. * * * It was obvious to those skilled in the art that a high intensity laser would remove the material, would vaporize the material without leaving a ridge. Isn't that the sum and substance of Caddell?

A. Yes, I would say so. It would be obvious to someone skilled in the art of lasers.

Q. Yes, sir.

A. That—that's how it would work out." (38a).*

The Court then heard Bausch & Lomb's patent law expert state the patent lists cross linked and non-cross linked material, and "that would strongly suggest that they [the inventors] did not regard [the] material when the application was filed, whether its cross-linked or not, as being that important." (40a-41a).

Bausch & Lomb's polymer chemical expert admitted:

"Q. [Dr. Salovey] Whether it's cross-linked or not cross-linked, it can be made to vaporize when subjected to sufficient heat?

* After lunch (38a), Dr. Mandell modified his testimony (39a-40a). The District Court was free to accept the original version as credible and reject, if it wished, the modified version.

A. Whether it's cross-linked or not cross-linked, if it is heated high enough, again vaporization, there's that loose word, it can be thermally decomposed by heat and go into a gas form which loosely is called vaporization. Yes." (41a-42a).

Petitioner's fact expert, Miller, experienced in the use of lasers, testified that he could laser mark all plastics, some with ridges, some without ridges and he did not care whether the plastics were cross-linked or not (42a).

The Court then questioned Mr. Miller.

"The Court: —Could you produce—You say you could produce a mark—could you produce a mark on a plastic contact lens without destroying the lens so that the lens would still be functional as a contact lens?

The Witness: Yes. Just a mark. You are saying a mark in the surface of the lens without destroying the lens. The answer would be yes.

The Court: All right.

Q. (By Mr. Calimafde) Was there anything in the literature or in practice prior to 1977 that would have discouraged you from believing or thinking that you could have made a laser mark in a plastic contact lens?

A. I would not have been too discouraged.

The Court: No, the question, was there anything in the literature that would have discouraged you.

The Witness: No, on the contrary.

The Court: Were you familiar with the literature at that time?

The Witness: Definitely." (43a-44a).

The District Court was aware of the credibility issue as to the weight to be given to different aspects of the expert testimony concerning the marking of plastics with or with-

out ridges. The Court heard and evaluated testimony favorable to both parties:

> The Court: In my notes, in my recollection, I recall, of this witness, was that prior to 1977 when he was marking plastics with lasers that he could make them with ridges or without ridges depending on how much intensity that he wished to apply to them. (44a).

During cross-examination, the Court's comments on this point are of interest:

> "Q. That would be pretty uncomfortable stuck in your eye blinking all day on a contact lens, wouldn't it?
>
> Mr. Calimafde: Your Honor, I don't see the relevancy of the examination at all, examining him on what is comfortable to his eye.
>
> The Court: I think he's getting as to whether or not—I think he is testing the weight that I should give to his testimony regarding the presence or non-presence of ridges on the plastics to which he applied the beam of—from the laser, I believe.
>
> Mr. Pretty: That's right.
>
> The Court: All right, I will allow it." (45a).

Based on the expert testimony of record, highlighted above, the District Court made two key obviousness findings: (1) that Caddell taught the use of a laser beam of high enough intensity to vaporize the material without melting to form a ridgeless depression (F-46), and (2) that any distinction between cross linked and non-cross linked

materials was unfounded, contrived and false (F-49, 26a).*

It was the province of the District Court, not the Federal Circuit, to determine the weight to be given to the expert and fact technical testimony. These findings, Nos. 46 and 49 (26a), as Rule 52(a) findings based on expert testimony, are dispositive of the obviousness issue.

e. *Other Obviousness Indicia Were Ruled Upon*

The District Court also evaluated the other objective indicia of obviousness, the *Graham* secondary considerations. The Court held there was no long-felt need because the lack of volume did not justify the expense of laser equipment. (F-79, 84, 30a, 31a).

The District Court made no findings as to failed attempts of others, or commercial success** due to the invention, although Bausch & Lomb had requested such findings (72a-73a), the District Court in evaluating the evidence, elected not to so find. These objective indicia of obviousness were absent.

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* "The Caddell patent teaches two ways of achieving a ridgeless depression; the first is to use a laser beam having a high enough intensity to *vaporize* the material without melting it, and the second is to use a material such as Delrin which tends to leave sharp edges when *melted*." (F-46, 26a).

"The examiner allowed the patent over Caddell only because plaintiff urged upon the examiner the unfounded and contrived distinction between cross-linked and non-cross-linked materials, and the false arguments regarding the propensity of non-cross-linked materials to form a ridge." (F-49, 26a).

(All underlining [here ital] in the findings by the District Court).

** Bausch & Lomb told the Federal Circuit it was not urging commercial success on appeal (74a).

The Federal Circuit's Decision

The Federal Circuit found three legal errors. Failure to refer to the presumption of validity; failure to make the requisite *Graham* findindgs and failure properly to interpret the scope of the claims. The District Court, however, used the clear and convincing standard (F-87, 32a) and, despite the omission of the use of the word "presumption", made findings, particularly F-46 and F-49, (26a), *supra*, p. 13 which are sufficient clearly to ascertain the legally correct basis of the District Court's decision.

This petition addresses the second legal error, the lack of *Graham* findings. Infringement is not involved in this petition; if obviousness is found, the third error as to infringement is moot.

The Federal Circuit then independently made factual determinations as to Caddell and whether a skilled person would be deterred from using laser marking of plastic contact lenses. Those determinations, coupled with the directive of remand to make findings not inconsistent with the appellate decision, in effect constituted Rule 52(a) findings.

Reasons for Granting Writ

The Federal Circuit made its own independent determinations as to subordinate factual issues, specifically the "teaching away" secondary consideration within the ultimate question of obviousness, 35 U.S.C. §103. The Circuit acted as a *de novo* fact finder reviewing expert and technical testimony. Rule 52(a) allocates that function exclusively to the trial court.

This petition should be granted since the Federal Circuit acted in direct contravention to each of *Anderson* v. *Bassemer City*, 470 U.S. 564, 105 S.Ct. 1504, 84 L.Ed. 518 (1985); *Icicle Seafood, Inc.* v. *Worthington*, 475 U.S. ——, 106 S.Ct. ——, 89 L.Ed.2d 739 (1986) and *Dennison Manufacturing Company*, 475 U.S. ——, 106 S.Ct. 1578, 89 L.Ed.2d 817 (1986). Patent and trademark cases are not an exception to Rule 52(a) and the Federal Circuit should apply the law as mandated by this Court.

ARGUMENT

POINT I

The Federal Circuit should not have made its own subtest finding.

Most of the trial testimony as to obviousness was concerned with Caddell and its significance as to teaching towards, or teaching away from the invention. In ordering remand, the Federal Circuit nevertheless made its own findings as to Caddell (1968), including the factual determination, the same as a finding, that Caddell taught away (11a). However, the findings adopted by the District Court, F-46 and F-49, (26a), *supra*, p. 13 which have not been held clearly erroneous were based on the expert and fact testimony concerning laser marking, and are contrary to the Federal Circuit's finding.

The Federal Circuit should not have made its own finding. *Icicle Seafoods, Inc.* v. *Worthington*, 475 U.S. ——, 106 S.Ct. , 89 L.Ed. 739, 744-5 (April 21, 1986). In so doing, the Federal Circuit accepted the expert testimony offered by Bausch & Lomb but rejected the version adopted

by the District Court. This practice was expressly disapproved in *Anderson* v. *Bessemer City*, 470 U.S. 564, 573, 84 L.Ed.2d 518, 528 (1985).

> This standard plainly does not entitle a reviewing court to reverse the finding of the trier of fact simply because it is convinced that it would have decided the case differently. The reviewing court oversteps the bounds of its duty under Rule 52 if it undertakes to duplicate the role of the lower court. "In applying the clearly erroneous standard to the findings of a district court sitting without a jury, appellate courts must constantly have in mind that their function is not to decide factual issues de novo." *Zenith Radio Corp.* v. *Hazeltine Research, Inc.*, 395 US 100, 123, 23 L.Ed.2d 129, 89 S.Ct. 1562 (1969). If the district court's account of the evidence is plausible in light of the record viewed in its entirety, the court of appeals may not reverse it even though convinced that had it been sitting as the trier of fact, it would have weighed the evidence differently. *Where there are two permissible views of the evidence, the factfinder's choice between them cannot be clearly erroneous. United States* v. *Yellow Cab* Co., 338 US 338, 342, 94 L.Ed. 150, 70 S.Ct. 177 (1949); see also *Inwood Laboratories, Inc.* v. *Ives Laboratories, Inc.*, 456 US 844, 72 L.Ed.2d 606, 102 S.Ct. 2182 (1982). (Emphasis added).

Since the key findings, F-46 and F-49, (26a), were not clearly erroneous, there was no bases for the Federal Circuit to find otherwise.

> The question we must answer, however, is not whether the Fourth Circuit's interpretation of the facts was clearly erroneous, but whether the District Court's finding was clearly erroneous. (*Ibid.*)

The Federal Circuit also went directly contrary to *Dennison* in making its teaching away determination. "Teaching away" was described in *United States* v. *Adams*, 383 U.S. 39, 51 (1966) as based upon "expressed disbelief by experts." This Court said that "a known disadvantage in old devices which would naturally discourage the search for the inventions may be taken into account in determining obviousness." This is an evidentiary matter entrusted to the District Court.

Teaching away, is therefore a secondary consideration which comes under *Dennison* and which the Federal Circuit could not decide *de novo*.

POINT II

The remand order was improper

While the Federal Circuit referred to the legal error (7a) in relying upon the inventor Hagar's opinion of obviousness (F-90; 32a), and the clearly erroneous finding as to Dr. Brucker's prior laser marking (F-91; 33a),* there were still adequate *Graham* findings to support the obviousness holding. An appellate court, reviewing these *Graham* findings, has no reason to remand, as the bases of the District Court's decision are still clear, understandable and correct. The correct standard of evidence "clear and convincing" was used by the District Court and its strong language used in Finding 49, *supra*, p. 13, is sufficient as a matter of law to overcome the presumption of validity.

* Evidence of Dr. Brucker's prior laser marking was contained in the portion of his deposition introduced into evidence by Bausch & Lomb (Exh. 27, pp. 17-19 56a-57a). However, we must now accept the Federal Circuit's ruling on this question.

Assuming the correctness of our Point I, the Federal Circuit's remand order should be vacated and summarily reversed.

Conclusion

It is respectfully requested that this petition be granted.

Respectfully submitted,

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Dated: May 29, 1987

APPENDIX

Opinion of Federal Circuit Court of Appeals

UNITED STATES COURT OF APPEALS

FOR THE FEDERAL CIRCUIT

Appeal No. 85-2578

BAUSCH & LOMB, INC.,

Appellant,

v.

BARNES-HIND/HYDROCURVE, INC., and BARNES-HIND INTERNATIONAL, INC.,

Appellees.

DECIDED: July 14, 1986

Before MARKEY, *Chief Judge,* FRIEDMAN, *Circuit Judge,* NICHOLS, *Senior Circuit Judge.*

NICHOLS, *Senior Circuit Judge*:

Appellant Bausch & Lomb, Inc. filed suit in the United States District Court for the Northern District of California, alleging that appellee Barnes-Hind/Hydrocurve, Inc. and Barnes-Hind International, Inc. (hereinafter Barnes-Hind) infringed patent No. 4,194,814 ('814 patent) in the manufacture and sale of its laser-marked contact lens. Barnes-Hind denied infringement and counterclaimed that the '814 patent was invalid, void, and unenforceable. In No. C-83-20283-RPA, Judge Aquilar found the patent invalid for obviousness and not infringed. We vacate and remand.

Opinion of Federal Circuit Court of Appeals

Appellee Barnes-Hind relied to a large extent on deposition testimony which was never introduced into evidence. Because this testimony was not in evidence, it would have been improper for us to consider it and, therefore, we did not. This eliminated much of Barnes-Hind's arguments on appeal.

Background

1. *The Technology*

Vision correcting contact lenses have become familiar; hard contact lenses were introduced in the early 1950's and soft lenses in 1971. Toric contact lenses, which correct for the eye condition known as astigmatism, have a similar history of usage: hard lenses from the early 1950's and soft from the first half of the 1970's. Toric lenses differ from standard contact lenses in having a prism base, *i.e.*, one edge portion of the lens is thicker. Proper prescription and fitting of toric lenses on the cornea of the eye requires alignment of a central lens axis with this prism base. Markings on the contact lens surface greatly facilitate the fitting process.

Inks and other substances have been used since the early 1950's, however, those marking procedures suffer several disadvantages: difficulty of accurate application with possible FDA disapproval; possibility of dissolution, blurring, and allergic reactions. Mechanical marking, as with a sharp scribing tool or an abrading tool such as a dental bur, is also available, but not without its problems: inaccurate and inconsistent positioning of the mark, lens damage, inadequate visibility, and the expense and time involved.

2. *The Patent*

The '814 patent, entitled Transparent Opthalmic Lens having Engraved Surface Indicia, discloses an engraved contact lens and provides a method of engraving using a source of high intensity electro-magnetic energy, such as a laser. The mark, not as deep as the lens is thick, is surrounded by a smooth surface of unsublimated or unaffected polymer material with the result that edges of the markings do not inflame or irritate the eyelid of the lens wearer.

The claims in suit are 1, 2, and 7. Claim 1 provides:

> An ophthalmic lens adapted to be placed in direct contact with eye tissue formed of a transparent cross-linked polymer material, said lens being characterized by identifying indicia engraved in a surface thereof by subjecting said lens to a beam of radiation emerging from a laser having an intensity and wavelength at least sufficient to sublimate said polymer and form depressions in said lens surface to a depth less than the thickness of said lens, said lens having a smooth surface of unsublimated polymer material surrounding said depressions, and by varying in a predetermined manner the point at which said laser beam impinges upon said lens surfaces to engrave said identifying indicia in said lens surface.

Claim 2 depends from claim 1 with the limitation that the lens is formed by a cross-linked hydrophilic (water loving) polymer. Claim 7, a product claim, is similar to claim 1 but defines the depressions as relieved zones.

3. *The Dispute*

In February 1976, Mr. Donald Hager, then production manager at the Milton Roy Company, a manufacturer of

soft contact lenses which was purchased by appellant Bausch & Lomb in 1979, sent to Carco, Inc., a distributor of laser equipment, six soft contact lenses for laser marking. At least two lenses were successfully marked. Around September 1976, Dr. David Fisher and Mr. James A. McCandless, also of Milton Roy Company, met with Mr. Hager to debrief him on the work. Soon thereafter, Mr. Hager resigned.

Dr. Fisher and Mr. McCandless continued to work on the lens-marking system, and in November 1977 filed an application for the patent in suit, listing themselves and Mr. Hager as inventors. Mr. Hager declined to execute the patent application, being at that time the employee of another lens manufacturing company, Sauflon International, Inc. and saying that he had not "invented anything in connection with laser marking of contact lens." He further said that he could not execute documents, under oath or otherwise, that represent the contrary. The Patent and Trademark Office (PTO) initially, and on a second occasion, rejected all the claims as obvious over two prior art U.S. patents to Brucker (No. 3,833,786) (teaching the use of a laser to fenestrate, *i.e.*, make holes, in contact lens to allow circulation of fluid through the lens) and to Caddell (No. 3,549,733) (disclosing the use of a laser to remove plastic from the surface of a printing plate to form a pattern). The PTO later issued the patent in 1980 as limited to a transparent cross-linked polymer having a smooth surface around the mark. Mr. Hager did sign as inventor in 1982. Meanwhile, Milton Roy commenced manufacture and marketing of laser-marked soft contact lenses in 1978.

Barnes-Hind's predecessor, Continuous Curve, Inc., introduced under the trademark HYDROCURVE a line of

soft toric lenses around 1975-76 that were marked with an indentation by a bur. In 1981, Barnes-Hind offered a soft toric lens marked by a laser.

Bausch & Lomb filed suit, contending that certain laser-marked contact lenses manufactured and sold by Barnes-Hind infringe claims 1, 2, and 7 of the '814 patent. Barnes-Hind denied infringement and counterclaimed that the patent was invalid, void, and unenforceable. The parties narrowed the issue of infringement to whether the marks on the HYDROCURVE lenses are surrounded by a smooth surface of unsublimated polymer material with respect to claims 1 and 2 or a smooth and unaffected surface for claim 7.

4. *The District Court Proceedings*

The district court determined that Barnes-Hind "proved by clear and convincing evidence that the patent in suit (4,194,814) and each of its claims is invalid and therefore void." It concluded that the differences between the claims and the prior art would have been obvious, finding that "the fact that the claimed subject matter of the patent in suit was obvious to Mr. Hager is most indicative of the obviousness of the invention," and that "Dr. Brucker's experiments in laser marking contact lenses are further evidence in support of this court's finding of obviousness." The court further concluded that scanning electron microscope (SEM) photographs, showing "that the surface of these lenses surrounding the laser mark are not 'smooth and unsublimated' or 'unaffected' as those terms were defined by plaintiff [appellant] during the processing of the patent in suit," demonstrated lack of infringement in any case. Bausch & Lomb appealed.

Opinion

The judgment is premised on several legal errors: (1) disregard of the presumption of validity established by 35 U.S.C. § 282; (2) absence of the factual findings on the four inquiries mandated by *Graham* v. *John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966); and (3) improper claim construction leading to the conclusion of noninfringement. We vacate the court's opinion and remand for a determination consistent with this opinion.

1. *Presumption of Validity*

A patent shall be presumed valid, and each claim shall be presumed valid independently of the validity of other claims. 35 U.S.C. § 282. The burden is on the party asserting invalidity to prove it with facts supported by clear and convincing evidence. *Loctite Corp.* v. *Ultraseal Ltd.*, 781 F.2d 861, 872, 228 USPQ 90, 97 (Fed. Cir. 1985); *Jones* v. *Hardy*, 727 F.2d 1524, 220 USPQ 1021 (Fed. Cir. 1984).

The record contains no reference to this statutory presumption of validity, nor does it appear that the district court considered separately the validity of the three claims at issue. By merely holding that "defendants have proved by clear and convincing evidence that the patent in suit (4,194,814) and each of its claims is invalid and therefore void," the district court improperly denied the '814 patent its statutory presumption of validity as to each claim.

The district court thought the examiner had been misled. Barnes-Hind argued and argues here that Bausch & Lomb (or rather its later acquired company Milton Roy) misled the examiner during prosecution. Appellees assert

that "if the examiner had been correctly and forthrightly informed of Hager's and McCandless' opinions, the chemistry of the Brucker lens, and the teaching of the Caddell patent, he would not have issued the patent." The record, however, does not support this assertion.

The examiner did know of Hager's temporary refusal to execute the application during prosecution and, as discussed more fully *infra*, a determination of nonobviousness is based, *inter alia*, on the opinion of a hypothetical person of ordinary skill in the art, not on the inventors' opinion. The weight to be attached to Hager's refusal cannot be exaggerated as the court below has done without clear error in view of Hager's self interest as an employee of a competitor and his later change of position. Instances of inventors refusing even to cooperate in obtaining issuance of a patent to be owned by an assignee are common and machinery is provided in 37 C.F.R. § 1.47 to deal with them. Section 1.47 provides that either a joint inventor or a proper assignee may file the application without the consent or signature of the inventor, just so the oath or declaration is accompanied by a petition including proof of pertinent facts. It is clear, therefore, that the PTO does not allow the inventor to erect that type of obstacle to obtaining patent protection. Such forethought is necessary, as otherwise an inventor's changed self interest might nullify a proper assignment. The district court's heavy reliance on Mr. Hager's assertions, if persisted in, would allow a co-inventor another chance at sabotage if the first effort has failed.

Finally, the examiner, who with the deference we owe governmental officials we assume has some expertise in interpreting the references and some familiarity with the

level of skill in the art, *American Hoist & Derrick Co.* v. *Soma & Sons, Inc.*, 725 F.2d 1350, 1359, 220 USPQ 763, 770 (Fed. Cir.), *cert. denied*, —— U.S. ——, 105 S. Ct. 95 (1984), did have the Brucker and Caddell patents before him. Barnes-Hind's "misleading the examiner" contention is insufficiently supported to overcome the presumption of validity.

As a final matter, we recognize, as the district court did not, that when the prior art before the court is the same as that before the PTO, the burden on the party asserting invalidity is more difficult to meet. *American Hoist*, 725 F.2d at 1359, 220 USPQ at 770.

2. *Graham Findings*

Obviousness under 35 U.S.C. § 103 is a question of law based on the underlying factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 17, 148 USPQ 459, 467 (1966): (1) the scope and content of the prior art; (2) the differences between the prior art and the claims at issue; (3) the level of ordinary skill in the art; and (4) objective evidence of secondary considerations. *See, e.g., Loctite*, 781 F.2d at 872, 228 USPQ at 97-98.

The *Loctite* court further stated:

> In patent cases, the need for express *Graham* findings takes on an especially significant role because of an occasional tendency of district courts to depart from the *Graham* test, and from the statutory standard of obviousness that it helps determine, to the tempting but forbidden zone of hindsight. Thus we must be convinced from the opinion that the district court actually applied *Graham* and must be presented with

> enough express and necessarily implied findings to know the basis of the trial court's opinion.

Id, 228 USPQ at 98.

Here, as in *Loctite* and in *Jones,* we are not convinced that the district court applied the *Graham* findings. Instead, it found Mr. Hager's opinion that the subject matter was obvious "most indicative of the obviousness of the invention." This was legal error.

Unlike the district court, we have the benefit of the very clear exposition of the law in *Standard Oil Co.* v. *American Cyanamid Co.,* 774 F.2d 448, 454, 227 USPQ 293, 297-98 (Fed. Cir. 1985):

> The issue of obviousness is determined entirely with reference to a *hypothetical* "person having ordinary skill in the art." It is only that hypothetical person who is presumed to be aware of all the pertinent art. The actual inventor's skill is irrelevant to this inquiry, and this is for a very important reason. The statutory emphasis is on a person of *ordinary* skill. Inventors, as a class, according to the concepts underlying the Constitution and the statutes that have created the patent system, possess something—call it what you will —which sets them apart from the workers of *ordinary* skill, and one should not go about determining obviousness under § 103 by inquiring into what *patentees* (i.e., inventors) would have known or would likely have done, faced with the relevation of references. [Emphasis in original.]

In this regard then, the district court erred at least three times: It relied too heavily on the alleged opinion of one who was an inventor and patentee, and misused that opinion as a substitute for determining the level of skill of

the hypothetical person of ordinary skill and what that person would have been able to do when in possession of the prior art, the scope and contents of which the court should also have determined.

The court also engaged in improper hindsight analysis to conclude the '814 patent would have been obvious. The court essentially adopted Barnes-Hind's argument that "the concept of forming ridgeless depressions having smooth rounded edges using a laser beam to vaporize the material is explicitly disclosed in the Caddell patent. *This is exactly the same process claimed in the patent-in-suit and practiced by the plaintiff.*"

Barnes-Hind selected a single line out of the Caddell specification to support the above assertion: "one way in which this [forming ridgeless depressions] can be achieved is to use a laser with high enough intensity to vaporize the plate material without melting it." Col. 5, lines 53-54. This statement, however, was improperly taken out of context. As the former Court of Customs and Patent Appeals held:

> It is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one skilled in the art.

In re Wesslau, 353 F.2d 238, 241, 147 USPQ 391, 393 (CCPA 1965); *see also In re Mercer*, 515 F.2d 1161. 1165-66, 185 USPQ 774, 778 (CCPA 1975).

A full appreciation of Caddell's statement requires consideration of the immediately following sentences in the

same paragraph and the paragraph after that. Viewed in that content, it is apparent that Caddell's ideal printing plate would have no ridges around the depression. The use of a high intensity laser is offered as a possible means to achieve the goal but is limited by several disadvantages. To overcome these disadvantages, Caddell suggests the use of a special class of polymer that forms ridgeless depressions. A complete reading demonstrates quite clearly that Caddell is setting up a strawman and pointing out its disadvantages to highlight the advantages of Caddell's invention, that special class of polymers. The district court improperly viewed an isolated line in Caddell in light of the teaching of the '814 patent to hold for obviousness. This is improper hindsight analysis.

The district court also failed to consider the Caddell reference in its entirety and thereby ignored those portions of the reference that argued against obviousness. *W. L. Gore & Associates, Inc.* v. *Garlock, Inc.*, 721 F.2d 1540, 1550, 220 USPQ 303, 311 (Fed. Cir. 1983), *cert. denied*, —— U.S. ——, 105 S. Ct. 172 (1984). Caddell compared the ridge formation of his special class of polymers against, *inter alia*, Lucite a copolymer composed of ethyl acrylate with methylmethacrylate—very similar to the chemical referred to in the '814 patent—and found that *only* his special class formed depressions without ridges. Thus, Caddell actually taught away from laser etching of soft contact lenses.

As further evidence of obviousness, the district court relied on Dr. Brucker's experiments in laser marking contact lenses. This too was error, in this case clearly erroneous factual error. The record does not support, indeed it contradicts, the supposition that Dr. Brucker had en-

gaged in laser marking of soft contact lenses at the time of the present invention. On page 385 of the Appendix, in reply to Mr. Calimafde's question "when did Continuous Curve begin to experiment with laser marking of soft contact lenses?", Dr. Brucker replied "I believe it was in '79 — '79, '80, somewhere in that area." The filing date of the '814 patent was November 10, 1977. Brucker's 3,833,786 patent for a method of fenestrating (putting windows in) contact lenses applies according to its claims to such lenses, both soft and hard. However, the record reflects that the need for such fenestration was as a mode of escape for fluid accumulating between the lens and the eye. Such a need does not exist respecting the soft lenses, the principal subject of the claims in suit, of which claim 2 is expressly limited to soft lenses. They, being hydrophilic, absorb the fluid.

In sum, the district court improperly determined the '814 patent was obvious: it failed to make the *Graham* inquiries, it improperly focused on what was obivous to the inventor, it engaged in hindsight analysis, and it considered evidence that was not prior art. This court, as an appellate court, may not make the required *Graham* factual findings, and must therefore remand that determination to the district court. The district court should not ignore the four-part analysis the authorities require.

a. *The scope and content of prior art*

To determine whether a reference is within the scope and content of the prior art, first determine if the reference is within the field of the inventor's endeavor. If it is not, then next consider whether the reference is reasonably per-

tinent to the particular problem with which the inventor was involved. *In re Richard M. Deminski,* No. 85-2267, slip op. at 9 (Fed. Cir. July 8, 1986); *Stratoflex, Inc.* v. *Aeroquip Corp.,* 713 F.2d 1530, 1535, 218 USPQ 871, 876 (Fed. Cir. 1983). *Orthopedic Equipment Co., Inc.* v. *United States,* 702 F.2d 1005, 1008-11, 217 USPQ 193, 196-97 (Fed. Cir. 1983) focused on the claims in suit, the art the PTO applied to the claims, and the nature of the problem confronting the inventor. Further, the art must have existed as of the date of invention, presumed to be the filing date of the application until an earlier date is proved.

b. *The differences between the claimed invention and the prior art*

The court must view the claimed invention *as a whole. See, e.g., Jones,* 727 F.2d at 1527-28, 220 USPQ at 1024. We add, as a cautionary note, that the district court appeared to distill the invention down to a "gist" or "core," a superficial mode of analysis that disregards elements of the whole. It disregarded express claim limitations that the product be an ophthalmic lens formed of a transparent, cross-linked polymer and that the laser marks be surrounded by a smooth surface of unsublimated polymer. *See also, ACS Hospital Systems, Inc.* v. *Montefiore Hospital,* 732 F.2d 1572, 221 USPQ 929 (Fed. Cir. 1984).

c. *Level of ordinary skill in the art*

In *Environmental Designs, Ltd.* v. *Union Oil Co.,* 713 F.2d 693, 697, 218 USPQ 865, 868-69 (Fed. Cir. 1983), *cert. denied,* 464 U.S. 1043 (1984), the court listed six factors relevant to a determination of the level of ordinary skill:

educational level of the inventor, type of problems encountered in the art, prior art solutions, rapidity of innovation, sophistication of technology, and educational level of active workers in the field. As to educational level of the inventor, *see Standard Oil Co.* v. *American Cyanamid Co.*, 774 F.2d 448, 227 USPQ 293 (Fed. Cir. 1985); *Orthopedic Equipment Co.* v. *All Orthopedic Appliances*, 707 F.2d 1376, 1382, 217 USPQ 1281, 1285 (Fed. Cir. 1983) ("Although the educational level of the inventor may be a factor in determining the level of ordinary skill in the art, it is by no means conclusive.")

d. *Objective indicia of obviousness*

Such "secondary considerations," when present, must always be considered. *Stratoflex*, 713 F.2d at 1538. *See also Cable Electric Products, Inc.* v. *Genmark, Inc.*, 770 F.2d 1015, 1026-28, 226 USPQ 881, 887-88 (Fed. Cir. 1985). Such evidence includes commercial success, long felt but unresolved needs, and failed attempts. *Perkin-Elmer Corp.* v. *Computervision Corp.*, 732 F.2d 888, 895-96, 221 USPQ 669, 675 (Fed. Cir.), *cert. denied*, —— U.S. ——, 105 S. Ct. 187 (1984).

We shall vacate the trial court's opinion and remand for an obviousness determination consistent with this opinion.

3. *Infringement*

The parties narrowed the infringement issue for trial to the question whether the surface of Barnes-Hind lenses surrounding the laser mark is "smooth and unsublimated" or "unaffected." The district court concluded that "the laser-engraved depressions in the surface of the HYDRO-

CURVE II lenses have been examined by scanning electron microscope. These photographs show that the surface of these lenses surrounding the laser mark are not 'smooth and unsublimated' or 'unaffected' as those terms were defined by plaintiff during the prosecution of the patent in suit." Appellant Bausch & Lomb argues on appeal that the trial court's approach of assessing smoothness at the very high levels of magnification obtainable by a SEM exceeds the level of smoothness required in the claims. We agree.

Because the first step in determining infringement is claim construction, improper claim construction can distort the entire infringement analysis. *Moeller* v. *Ionetics, Inc.*, No. 85-2646, slip op. at 7 (Fed. Cir. June 4, 1986). Such a distortion occurred below.

Disputed issues such as the meaning of the term "smooth," should be construed by resort to extrinsic evidence such as the specification, other claims, and the prosecution history. Here, resort to the specification clearly demonstrates that "smooth" meant that "the edges of the craters neither inflame nor irritate the eyelid of the lens wearer * * *. The markings provided on the lens surface in accordance with this invention * * * are not perceived by the lens wearer * * *." The prosecution history supports this construction. A reading of the amendment and its accompanying remarks demonstrates that smooth means the absence of a ridge that "would scratch either the eye or eyelid and would lead to infection." There is no indication that smooth means absolutely ridge-free. (This review of the prosecution history also leads us to disagree with Barnes-Hind's final argument that the prosecution history estops Bausch & Lomb from asserting infringement against

the allegedly ridged HYDROCURVE lens.) Testimony from Dr. Mandell, Bausch & Lomb's expert in the field of contact lenses, indicates that to a person of ordinary skill in the art, smooth would mean an absence of "roughness or significant elevation" so that a wearer "would not feel it with the [eye]lid." Further, there is testimony that a person of ordinary skill in the art would use an optical microscope, not an SEM, to gauge the relative smoothness of an etched contact lens.

We hold that smooth means smooth enough to serve the inventor's purposes, *i.e.*, not to inflame or irritate the eyelid of the wearer or be perceived by him at all when in place. Accordingly, we vacate the district court's conclusion that the surface of the HYDROCURVE lenses are not smooth or unaffected, and remand for a determination of infringement based on the proper construction of and proper test for smooth.

Conclusion

We vacate the district court's determination that the '814 patent is invalid and remand for a reconsideration of validity in light of the presumption of validity and the *Graham* findings on obviousness. We further vacate the decision of noninfringement and remand for proper claim construction and infringement analysis.

VACATED AND REMANDED

Judgment and Mandate

UNITED STATES COURT OF APPEALS

FOR THE FEDERAL CIRCUIT

Appeal No. 85-2578

BAUSCH & LOMB, INC.,

Appellant,

v.

BARNES-HIND/HYDROCURVE, INC., and BARNES-HIND INTERNATIONAL, INC.,

Appellees.

ON APPEAL from the United States District Court of the Northern District of California in Case No. C-83-20283-RPA.

This CAUSE having been heard and considered, it is ORDERED and ADJUDGED:

VACATED AND REMANDED.

ENTERED BY ORDER OF THE COURT

/s/ FRANCIS X. GINDHART

FRANCIS X. GINDHART, Clerk

DATED JUL 14 1986

ISSUED AS A MANDATE: MAR 17 1987

Denial for Petition for Rehearing

UNITED STATES COURT OF APPEALS

FOR THE FEDERAL CIRCUIT

Appeal No. 85-2578

BAUSCH & LOMB, INC.,

Appellant,

v.

BARNES-HIND/HYDROCURVE, INC., and BARNES-HIND INTERNATIONAL, INC.,

Appellees.

Before MARKEY, *Chief Judge,* FRIEDMAN, *Circuit Judge,* and NICHOLS, *Senior Circuit Judge.*

ORDER

A petition for rehearing having been filed in this case,

UPON CONSIDERATION THEREOF, it is

ORDERED that the petition for rehearing be, and the same hereby is, denied.

FOR THE COURT

/s/ FRANCIS X. GINDHART

FRANCIS X. GINDHART, Clerk

Date 3/10/87

cc: Mr. Laurence H. Pretty
Mr. John M. Calimafde

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

Appeal No. 85-2578

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

No. C 83-20283 RPA

BAUSCH & LOMB INCORPORATED, a corporation,
Plaintiff,

vs.

BARNES-HIND/HYDROCURVE, INC., a corporation, and BARNES-HIND INTERNATIONAL, INC., a corporation,
Defendants.

FINDINGS OF FACT AND CONCLUSION OF LAW

(1) Plaintiff, Bausch & Lomb Incorporated is a New York corporation having its principal place of business in Rochester, New York.

(2) Defendant, Barnes-Hind/Hydrocurve, Inc. is a Delaware corporation having its principal place of business in Sunnyvale, California.

(3) Defendant, Barnes-Hind International, Inc. is a Delaware corporation having its principal place of business in Sunnyvale, California.

(4) Defendant Barnes-Hind International, Inc. is a wholly owned subsidiary of Defendant, Barnes-Hind/Hydrocurve, Inc.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(5) This is a civil action for infringement of U.S. Patent No. 4,194,814 entitled "Transparent Ophthalmic Lens Having Engraved Surface Indicia" issued on May 25, 1980 to David J. Fischer, James A. McCandless and James D. Hager. (hereinafter "the patent in suit" or "the '814 patent".)

(6) Plaintiff contends that certain laser marked contact lenses manufactured and sold by Defendants under the trademark HYDROCURVE II infringe the '814 patent.

(7) Defendants deny infringement and by way of counterclaim seek a declaration that the patent in suit is invalid, void and unenforceable.

(8) At the time of the patent application, the inventors were employed by a Florida company, Milton Roy Company, which manufactured soft contact lenses. The patent application for their invention was assigned to Milton Roy Company.

(9) Plaintiff, the present owner of the '814 patent, is a manufacturer of soft contact lenses and other optical products. It became the owner of the '814 patent as a result of its purchase in 1979 of the soft contact lens manufacturing business of Milton Roy Company.

(10) Defendants, as well as a precedessor company of Barnes-Hind/Hydrocurve, Continuous Curve Contact Lenses, Inc., also are engaged in the business of manufacturing various types of contact lenses, including hard and soft lenses.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(11) Hard contact lenses came into general use in the early 1950s. The most widely used material for hard contact lenses has been polymethyl methacrylate (PMMA).

(12) Soft contact lenses generally became available to the public in about 1971. (The most widely used materials for soft contact lenses are hydrophilic cross-linked polymers, such as polyhydroxy-ethylmethacrylate (HEMA).)

(13) Contact lenses having an optical configuration to correct for astigamatism are referred to as toric lenses.

(14) Hard toric contact lenses have been available since the early 1950s.

(15) Soft toric lenses became available during the first half of the 1970s.

(16) Hard and soft toric lenses differ from conventional contact lenses in that they are thicker at one edge portion of the lens, this thickened portion being referred to as the prism base of the lens.

(17) In order for a toric lens to be properly prescribed for and fitting on an astigmatic eye, it is necessary that the fitter be able to locate and identify a central lens axis aligned with the prism base when the lens is placed on the cornea to determine the correct orientation of the lens on the eye. Markings on the lens surface greatly facilitate this fitting process.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(18) Since the introduction of hard toric lenses, inks and other marking substances have been used to provide markings on toric lenses.

(19) Problems arising with the use of marking substances include difficulty of applying the substance accurately at the center of the prism base; dissolving or blurring out of the marking; the possibility of allergic eye reaction to the marking substance; and the difficulties of obtaining FDA approval.

(20) Another approach has involved mechanical marking of the lens surface, for example by using a sharp scribing tool or an abrading tool such as a dental burr.

(21) Problems associated with mechanical marking include difficulty in accurate and consistent positioning of the lens mark; opportunity for lens damage; sometimes inadequate mark visibility for the fitter; and its relatively expensive and time-consuming character.

(22) The patent in suit claims a contact lens formed of a transparent cross-linked polymer material which includes a mark on its surface made by a laser, including a process for making such lens.

(23) The claims require that the area contiguous to the mark be smooth and unaffected.

(24) The specification of the patent in suit indicates that the process is applicable to *any contact lens*, including hard and soft type lenses.

(25) The patent specification does not distinguish between different plastic lens materials with respect to the suitability of marking by laser.

(26) The Patent Office initially and on a second occasion rejected all the claims as being "obvious" and therefore unpatentable over certain "prior art" patents, namely, U.S. Patents 3,833,786 (Brucker) and 3,549,733 (Caddell).

(27) The Caddell patent discloses the use of a laser to remove plastic from the surface of a printing plate to form a pattern.

(28) The Caddell patent discloses the partial penetration or etching of a plastic material; etching is the same as marking.

(29) The Brucker patent teaches the use of a laser to fenestrate, i.e. to make holes, in a plastic contact lens.

(30) In view of the teaching of Caddell and Brucker, the Patent examiner concluded that it was "obvious" and, therefore, unpatentable to laser-mark the plastic contact lens disclosed in Brucker to a partial depth as taught in Caddell.

(31) In response to the examiner's rejection based on obviousness, plaintiff narrowed the scope of the patent claims by adding the limitations that the plastic material was "transparent" and "cross-linked" and further that the area surrounding the mark was "smooth" and "unsublimated", or "smooth and unaffected".

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(32) In that same response, plaintiff urged allowance of the narrowed claims on the ground that while the non-cross-linked material disclosed by Caddell tended to melt and form a ridge around the depression, the cross-linked material recited in the claims vaporized when struck by the laser beam so that no ridge was formed around the depressed (i.e. etched) area.

(33) With respect to the non-cross-linked compound disclosed by Caddell (Delrin) which did not form a ridge when melted, plaintiff argued that the material was not transparent and was, therefore, unsuitable for use as a contact lens.

(34) Plaintiff also argued that the Brucker patent was limited to fenestrating "hard" contact lens and was, therefore, not relevant to his claimed (soft) contact lens.

(35) Notwithstanding the above arguments, on May 24, 1979, the examiner again and finally rejected the claims based on the Caddell and Brucker patents.

(36) Plaintiff then had a personal interview with the examiner and after the interview, the examiner allowed the claims.

(37) In an Official Letter to plaintiff, the examiner indicated that he was allowing the claims because the prior art did not disclose specifically the "transparent cross linked . . . having smooth surfaces of unsublimated polymer".

(38) Based on this distinction, the patent issued.

(39) The Brucker patent discloses a method of laser fenestration of contact lenses. The Brucker patent is applicable to cross-linked and non-cross-linked lens materials.

(40) The Brucker patent teaches that the fenestration of a contact lens using a laser results in a hole, the edges of which are "smooth and polished".

(41) The difference between partially penetrating, i.e., marking, and completely penetrating, i.e., fenestrating, is a mere difference in degree and a matter of choice.

(42) Plaintiff misled the examiner when he argued that Brucker was limited to "hard" lenses, and implied that hard lenses were non-cross linked. In fact, the Brucker lenses were commercially sold and were made of cross-linked material; the laser-made holes were also surrounded by smooth and unsublimated surfaces. If the examiner was not misled and had correctly understood the Brucker disclosure, he could not have allowed the patent in suit for the reason stated by him.

(43) The Caddell patent is directed to surface etching plastic printing plates using a laser.

(44) The Caddell patent explains that to produce a printed plate of high quality, the formation of ridges around the etched patterns must be avoided.

(45) The Caddell patent further explains that the plate should be smooth except in the area of the depression.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(46) The Caddell patent teaches two ways of achieving a ridgeless depression; the first is to use a laser beam having a high enough intensity to *vaporize* the material without melting it, and the second is to use a material such as Delrin which tends to leave sharp edges when *melted.*

(47) The Caddell patent also teaches that when using a laser beam having an intensity sufficient to vaporize plastic material, some melting and therefore "rounding" of the edges would occur which is unsatisfactory in a printing plate. The rounded edges are, however, most desirable in a contact lens.

(48) Thus, the concept of forming ridgeless depressions having smooth rounded edges in plastic using a laser beam to vaporize the material is explicitly disclosed in the Caddell patent. *That is exactly the same process in the patent-in-suit and practiced by plaintiff.*

(49) The examiner allowed the patent over Caddell only because plaintiff urged upon the examiner the unfounded and contrived distinction between cross-linked and non-cross-linked materials, and the false arguments regarding the propensity of non-cross-linked materials to form a ridge.

(50) In about 1960 Donald Brucker formed a company known as Continuous Curve.

(51) In the early 1970's, Brucker developed and commercialized a process known as LASER-CON for laser fenestrating contact lenses.

(52) The purpose of fenestrating a contact lens was to aid in the circulation of pre-corneal fluid which is a natural result of blinking.

(53) Brucker commercially fenestrated hard contact lenses which were made of a plastic material known as poly methyl methacrylate (PMMA).

(54) The Glassflex material fenestrated by Mr. Brucker using the Laser-Con process was a cross-linked material.

(55) The Laser-Con process was not limited to hard contact lenses; rather it could be used to fenestrate both hard and soft contact lenses.

(56) The holes produced by the Laser-Con process had smooth and rounded edges at both the posterior and anterior surfaces.

(57) In addition to the hard lenses which Continuous Curve commercially fenestrated using a laser, it fenestrated and surface-marked soft contact lenses made of a material known as poly hydroxyethyl methacrylate (PHP) for clinical use.

(58) PHP is a cross-linked polymeric material.

(59) Milton Roy Company began producing soft contact lenses in approximately 1974 and received FDA approval to sell those lenses in 1976.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(60) From 1974 to 1976 the Milton Roy Company was not marking its soft contact lenses in any manner.

(61) In February 1976 the Production Manager of Milton Roy Company, Mr. James D. Hager, (one of the patentees), saw an advertisement from a company called Lumonics who was in the business of laser marking a wide variety of materials and products including plastics.

(62) Inspired by this advertisement, Mr. Hager, on April 8, 1976, forwarded six (6) lenses to the Lumonics Company requesting that those lenses be marked. The lenses were made of cross-linked material.

(63) Lumonics marked those lenses and returned them to Mr. Hager.

(64) Upon their return and examinatiton by Mr. Hager, the lenses were found to be satisfactory.

(65) Up to that event, Mr. Fisher and Mr. McCandless, the other named patentees, contributed absolutely nothing to the subject matter of the patent in suit.

(66) Mr. Hager left the employ of Milton Roy in approximately September 1976.

(67) At no time did Mr. Hager or the other named inventors attempt to laser mark or have Lumonics laser-mark a non-cross-linked contact lens.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(68) On September 15, 1977, prior to filing the application which led to the patent-in-suit, Mr. Hager was requested by Milton Roy to execute the proposed application.

(69) In a letter dated September 30, 1977 Mr. Hager declined to execute the proposed application stating that he did not feel he had invented anything in connection with laser marking contact lenses and specifically that he did not believe any of the results he had obtained were unexpected.

(70) Notwithstanding Mr. Hager's belief, Milton Roy filed the proposed patent application on November 10, 1977.

(71) On August 12, 1982, after receiving the Notice of Allowance of the patent-in-suit the attorney for Bausch & Lomb Inc. contacted Mr. Hager and requested him to join as an inventor.

(72) In a letter dated August 12, 1982, the attorney for Bausch & Lomb, Inc. stated that Milton Roy's attorney had filed a prior art statement. Mr. Hager, however, was never given a copy of the patents included in the prior art statement nor the patents cited by the examiner.

(73) Mr. Hager was never advised of the arguments made by Milton Roy's attorney to the Patent examiner.

(74) After receiving a check in the amount of $610, for "consulting services", Mr. Hager executed the necessary Declaration and Power of Attorney and Assignment papers.

(75) Mr. Hager, even as of the date of his pre-trial deposition, did not believe he made any "invention" or that laser marking was an "invention".

(76) Mr. John Jakoski, Vice President of Manufacturing of Barnes/Hind/Hydrocurve, was primarily responsible for defendants commercialization of its laser marked toric lenses.

(77) Prior to his employment with Barnes/Hind/Hydrocurve (previously known as Continuous Curve), he was employed for 14 years by Ocular Products as a product manager for prescription contact lenses.

(78) In the late sixties and early seventies, during his employment with Ocular Plastics, Mr. Jakoski became aware of the Laser-Con process used by Brucker in laser fenestration of lenses.

(79) During his employment with Ocular Products, Mr. Jakoski discussed the use of a laser to mark lenses, however, Ocular Products did not develop such a project because of a lack of volume to justify the expense of purchasing laser marking equipment.

(80) In about 1976, a technician at Continuous Curve showed Mr. Jakoski one or two soft lenses which were laser marked with a circular dot to differentiate the right and left lens.

(81) In approximately the middle of 1979, the defendants commercialized their first soft toric lenses under the

tradename Hydrocurve II_{45} (45 represents the percentage of water contained in the lens material). The initial marking was made by using a mechanical tool. The mechanical tool was used for marking until about March of 1982, at which time the volume of sales made it commercially feasible for Barnes-Hind/Hydrocurve to change over to an automated system.

(82) In about November of 1981, Barnes-Hind/Hydrocurve also commercialized a second line of toric lenses under the tradename Hydrocurve II_{55}. The marks for those lenses were applied using a laser.

(83) From November 1981 until March 1982, Barnes-Hind/Hydrocurve was using both the mechanical tool and the laser for marking toric lenses.

(84) In 1987, Mr. Jakoski knew that another company called Sauflon was laser-marking soft contact lenses. Thus, knowledge of another company using the laser marking process could not have been the motivation for defendants to use such process as they did not begin to use such process until November of 1981 when the volume of sales justified the expenses of the laser marking equipment.

(85) Barnes-Hind/Hydrocurve did not copy the idea of using a laser to mark soft contact lenses from plaintiff nor its predecessor company, Milton Roy. Brucker who had been using a laser for many years prior to the patent in suit testified that the use of a laser to mark a lens, either soft or hard, was always present in his mind. There was simply

no earlier need to use the laser marking process; when the need arose, it was the obvious process to use.

(86) The laser-engraved depressions in the surface of the HYDROCURVE II lenses have been examined by scanning electron microscope. These photographs show that the surface of these lenses surrounding the laser mark are not "smooth and unsublimated" or "unaffected" as those terms were defined by plaintiff during the processing of the patent in suit.

(87) Defendants have proved by clear and convincing evidence that the patent in suit (4,194,814) and each of its claims is invalid and therefore void.

(88) The differences between the matters claimed in the patent and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a persor of ordinary skill in the art to which the invention pertains.

(89) Dr. Brucker's failure to file a patent application regarding his invention of laser marking contact lenses and fenestrating soft contact lenses cannot be deemed abandoned, suppressed or concealed.

(90) The fact that the claimed subject matter of the patent in suit was obvious to Mr. Hager is most indicative of the obviousness of the invention.

Findings of Fact and Conclusions of Law of The Hon. Robert P. Aguilar, U.S.D.J.

(91) Dr. Brucker's experiments in laser marking contact lenses are further evidence in support of this court's finding of obviousness.

(92) Defendants have not infringed any valid patent.

(93) Plaintiffs are not entitled to a finding of validity.

(94) Plaintiffs are not entitled to a finding of infringement.

(95) Plaintiffs are not entitled to an award of damages.

(96) Plaintiffs are not entitled to an award of attorneys fees.

(97) Since the court has found the patent in suit to be invalid because of obviousness there is no need for a hearing on the issue of damages.

Any finding of fact which is actually a conclusion of law is deemed to be a conclusion of law. Any conclusion of law which is actually a finding of fact is deemed to be a finding of fact.

IT IS SO ORDERED.

DATED: June 10, 1985.

/s/ ROBERT P. AGUILAR

ROBERT P. AGUILAR
United States District Judge

Judgment Declaring Patent Invalid and Void

APPEAL No. 85-2578

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

No. C 83-20283 RPA

BAUSCH & LOMB INCORPORATED, a corporation,
Plaintiff,

vs.

BARNES-HIND/HYDROCURVE, INC., a corporation, and BARNES-HIND INTERNATIONAL, INC., a corporation,
Defendants.

The above-entitled matter having been tried to the Court without a jury, Robert P. Aguilar, United States District Judge presiding, and the Court having heard all of the testimony, reviewed all of the evidence, and heard the argument of counsel now makes its judgment as follows:

The Court has filed Findings of Fact and Conclusions of Law contemporaneously herewith and incorporates them in this judgment as if set forth in full.

Good cause appearing therefor, it is adjudged and decreed that U.S. Patent No. 4,194,184 entitled "Transparent Ophthalmic Lens Having Engraved Surface Indicia" issued on May 25, 1980, should be, and the same is hereby, declared to be invalid and void for all purposes.

Judgment Declaring Patent Invalid and Void

It is adjudged that plaintiff take nothing by its complaint herein.

It is ordered that Defendants are awarded their costs of suit.

IT IS SO ORDERED.

DATED: June 10, 1985.

/s/ ROBERT P. AGUILAR

ROBERT P. AGUILAR
United States District Judge

Robert D. Mandell for Plaintiff

ROBERT D. MANDELL

The Witness: I am Robert Mandell. I am a professor of physiological optics and optometry at the University of California, Berkeley.

* * *

The Court: All right. There's two areas wherein I think you may require some further showing of expertise and that is in the area of marking and in the area of prior art. Now, in the area of smoothness, certainly in physiological optics he would be familiar with smoothness because necessarily he certainly would want to check for any rough edges on the cornea, but these other two areas, prior art and marking, I think you should elicit more expertise if any from him. (Tr. 11)

* * *

Cross-examination by Mr. Calimafde:

* * *

Q. Now, it was known prior to November, 1977, and so that there's no mystery about that date, that is the filing date of the patent and suit was November 10, 1977, so if I ask you questions about things which occurred to your knowledge prior to November 10, 1977, I have picked that date because it is the filing date of the patent and for no other reason.

Now, it was known prior to that date to drill a hole through a lens using a mechanical drill. Isn't that true, sir? A. Yes.

Q. And it was known prior to that date to drill a hole through a lens using a laser. Isn't that true, sir? A. Yes.

Q. Now, it was known prior to that date to mark the surface of a lens using a drill but going only partway into the thickness of the lens. Isn't that true? A. Yes.

Q. And wouldn't it be—have been the most obvious thing in the world to have taken the laser which has gone all the way through the lens to use it to go only partway through the lens as you did with the drill? A. If you knew a laser was capable of doing that.

Q. And that was all that was missing in the equation to your knowledge, that a laser was capable of going partway. Is that correct, sir? A. I would say that's the most important thing, yes. (Tr. 53)

* * *

Q. Is it your testimony that if it was known to the skilled person that the depth of the laser could be controlled, then it would have been obvious to use the laser to mark the lens? A. If I had known that I could do that with the materials that were used for a contact lens, yes. (Tr. 55)

* * *

The Court: Before you do that, let me take one of the answers and see if I could understand it.

You are saying that had you had the knowledge that the laser beam could be controlled in such a manner that you could regulate its depth of penetration into the lens for marking purposes, that it would then be obvious—

Mr. Calimafde: To use it.

The Court:—To use it.

The Witness: If I had known it would work on the material which is in the contact lens in that way.

The Court: Then it would be obvious to use this as another means of marking the lens?

The Witness: Yes. (Tr. 56)

* * *

Q. So doesn't he, Dr. Mandell, say in effect that one may use a laser to create a depression, and if one does not desire to have a ridge on—around that depression, one could do it by a high intensity beam to vaporize that material or he says he—I have found a cheaper way. I have found that Delrin will do that for you with a lower-powered laser. He says my—Caddell says, my invention was the discovery that Delrin does it for you, QED. It was obvious to those skilled in the art that a high intensity laser would remove the material, would vaporize the material without leaving a ridge. Isn't that the sum and substance of Caddell? A. Yes, I would say so. It would be obvious to someone skilled in the art of lasers.

Q. Yes, sir. A. That—that's how it would work out. (Tr. 70)

* * *

Mr. Calimafde: Your honor, we are recessed now until what time?

The Court: One-thirty this afternoon.

Thank you.

(Whereupon, at 12:50 P.M. this date the luncheon recess was taken until 1:30 P.M. this date.) (Tr. 77)

* * *

Robert D. Mandell for Plaintiff

Monday, May 20, 1985 *1:47 o'clock P.M.*

The Court: Good afternoon. Please be seated.

* * *

Redirect Examination (resumed) by Mr. Pretty:

Q. Over the lunch recess have you had an opportunity to read that patent and satisfy yourself about it now? A. Yes, I have.

Q. The Caddell patent. (Tr. 78)

* * *

Q. Now, as I understand it, you were asked on your cross-examination if it would have been obvious to one of ordinary skill to take the material that was used by Mr. Brucker and use it in the process of Mr. Caddell to end up with a contact lens that wouldn't have ridges. Do you recall a question of that nature? A. Yes, more or less.

Q. What is your answer on that? A. I don't think it would have been obvious to take the material that Dr. Brucker was working with at the time and apply the teachings of Caddell and come up with the etching process.

Q. Could you explain the reasoning that you, that leads you to that conclusion? A. Well, the first reasoning is that it wasn't obvious to me to do it at the time. And I had knowledge—well, I didn't have knowledge of the Caddell patent at the time. I had a certain limited knowledge about lasers. It was my impression looking at the process done by Dr. Brucker that it was not all that easy to control the amount of energy going through the laser, that it was sort of all or none process. You—you effectively burned a hole all the way through the material or nothing else. Now,

having the knowledge of Caddell and reading the patent carefully, it's my impression that the techniques that Caddell describes in the patent were intended to apply to only a very limited number of materials relating to Delrin, in the family of Delrin, and that this process did not work on other polymers including methyl methacrylate which was the material of the contact lens.

Mr. Pretty: I have no further redirect. (Tr. 79-80)

* * *

WILLIAM E. THOMSON

The Clerk: Please be seated. State your full and complete name and occupation for the record.

The witness: My name is William E. Thomson, T-H-O-M-S-O-N. I am an attorney.

The Court: Good afternoon, Mr. Thomson. (Tr. 122)

* * *

Q. Would you tell us where to look in the file history? A. Yes, in the patent itself. The patent itself lists materials which are both cross-linked and materials which are not cross-linked and since the patent was reviewed and signed by the inventors, that would strongly suggest that they did not regard material when the application was filed, whether it's cross-linked or not, as being that important. (Tr. 220)

* * *

Q. When you stated a moment ago that the patent included polymers which are both cross-linked and noncross-linked, do you wish to withdraw that testimony? A. No, I do not. I think the testimony stands. I think you will have

to recall that the patent examiner specifically referred to cross-linked polymers, linear polymers, hydrophilic, hydrophobic, et cetera. (Tr. 222)

* * *

RONALD SALOVEY, called as a witness, after having been previously duly sworn by the clerk to tell the truth, the whole truth, and nothing but the truth, testified further: (Tr. 288)

Direct examination (resumed) by Mr. Pretty:

* * *

The Court: Very good.

The Witness: Okay. If the monomer unit has more than two attachments, then the connection of this into a polymer may lead to a polymer which we refer to as cross-linked. And a cross-linked polymer might link something like this. This, per se, is not a cross-linked polymer, but if I keep repeating the process I will have a polymer in a highly intertwined state and that is referred to as cross-linked. Now, the main characteristic of cross-linked polymers are that cross-linked polymers do not melt, they are infusible. And they are insoluble. And that means that they do not melt and they do not dissolve. And most of the materials used in soft contact lenses are cross-linked polymers. And sometime later—just not to make this completely dull, I would like to talk about the effect of heat to polymers because the laser action is basically intense local heating of the polymer. (Tr. 293)

* * *

Q. Whether it's cross-linked or not cross-linked, it can be made to vaporize when subjected to sufficient heat? A. Whether it's cross-linked or not cross-linked, if it is heated

high enough, again vaporization, there's that loose word, it can be thermally decomposed by heat and go into a gas form which loosely is called vaporization. Yes. (Tr. 355)

* * *

The Court: Mr. Miller, please come forward, sir.

RICHARD MILLER

Q. (By Mr. Calimafde). Now, did you know the chemistry of the plastics that you laser-marked, for example, whether they were cross-linked or not cross-linked or what have you? A. No, we had no knowledge of that.

Q. Did you care whether they were cross-linked or not? A. No, we did not care.

Q. Do you recall any plastic that you tried to mark but you were unsuccessful in marking with a laser? A. No.

Q. Any plastic which you could not mark? A. I have never run across a plastic that I could not mark.

Q. Now, in marking these various materials were you concerned about producing a ridge around the depression? A. Yes.

Q. And did some materials produce ridges around the depression? A. Yes.

Q. And did some materials mark without producing ridges? A. Yes. (Tr. 398)

* * *

Q. Let's talk about the period of prior to 1977. If you had been asked then prior to 1977 whether you could mark a plastic lens material with a laser, do you have an opinion as to what your answer would have been? A. Yes, I have such an opinion.

The Court: At that time with the equipment then avaliable to you.

The Witness: I have an opinion.

Mr. Calimafde: And what is that?

The Court: Just a minute.

Mr. Pretty: I just wish to repeat my objection for the record that this is improper opinion testimony from the unqualified witness.

The Court: Overruled.

Q. (By Mr. Calimafde) And what is that opinion? A. I would have believed at that time that I would be able to produce a mark with a laser in a plastic contact lens.

Q. Now, was there anything at that time, the beginning of 1977—

The Court: Excuse me, Mr.—

Mr. Calimafde: Calimafde.

The Court:—Calimafde. Could you produce—you say you could produce a mark—could you produce a mark on a plastic contact lens without destroying the lens so that the lens would still be functional as a contact lens? (Tr. 404)

The Witness: Yes. Just a mark. You are saying a mark in the surface of the lens without destroying the lens. The answer would be yes.

The Court: All right.

Q. (By Mr. Calimafde) Was there anything in the literature or in practice prior to 1977 that would have discouraged you from believing or thinking that you could have made a laser mark in a plastic contact lens? A. I would not have been too discouraged.

The Court: No, the question was, was there anything in the literature that would have discouraged you.

The Witness: No, on the contrary.

The Court: Were you familiar with the literature at that time?

The Witness: Definitely.

The Court: And did you read the literature on a regular basis?

The Witness: I was subscribing to many trade magazines in my field.

The Court: That was going to be my next question. Did you belong to any associations in the field?

The Witness: I didn't at that time.

The Court: But you did subscribe to trade magazines and the like?

The Witness: Oh, yes. (Tr. 405)

* * *

The Court: In my notes, in my recollection, I recall, of this witness, was that prior to 1977 when he was marking plastics with lasers that he could make them with ridges or without ridges depending on how much intensity that he wished to apply to them.

Mr. Calimafde: That's correct, sir. (Tr. 415)

* * *

Q. Would you turn to column 6—the patent has numbered columns on it.

Now, you have seen this patient before, haven't you? A. Yes.

Q. Now, if you look in column 6 on table 1 it has a material there that's referred to as Lucite and in the column D

it shows a dimension which apparently relates back to figure 6 where there is a dimension D which shows a ridge. Do you see that little D? A. Under Lucite where it says two thousandths?

Q. Yes. That is more than ten times what you can feel with your finger as a ridge, isn't it? A. Yes.

Q. That would be pretty uncomfortable stuck in your eye blinking all day on a contact lens, wouldn't it?

Mr. Calimafde: Your Honor, I don't see the relevancy of the examination at all, examining him on what is comfortable to his eye.

The Court: I think he's getting as to whether or not—I think he is testing the weight that I should give to his testimony regarding the presence or non-presence of ridges on the plastics to which he applied the beam of—from the laser, I believe.

Mr. Pretty: That's right.

The Court: All right, I will allow it. (Tr. 426-7)

* * *

The Court: It's my practice to go over my notes and I have rather copious notes as you can see and I will review the notes. I reviewed them this morning to refresh my recollection because I have been gone for a week and I will review them again tonight and if I have any questions now that I have the whole picture, I will pose them to you tomorrow morning. (Tr. 581)

* * *

Plaintiff's Trial Exhibit 1; Fischer, et al.
Patent No. 4,194,814

United States Patent [19]

Fischer et al.

[11] **4,194,814**

[45] **Mar. 25, 1980**

[54] **TRANSPARENT OPTHALMIC LENS HAVING ENGRAVED SURFACE INDICIA**

[75] Inventors: **David J. Fischer, Sarasota; James A. McCandless, St. Petersburg, both of Fla.; James D. Hager, Santa Monica, Calif.**

[73] Assignee: **Bausch & Lomb Incorporated, Roch... N.Y.**

[21] Appl. No.: **850,133**

[22] Filed: **Nov. 10, 1977**

[51] Int. Cl.² G02C 7/04

[52] U.S. Cl. ..... 351/160 R; 346/76 L; 351/160 H; 358/297

[58] Field of Search ..... 351/160, 177; 358/297; 346/76 L

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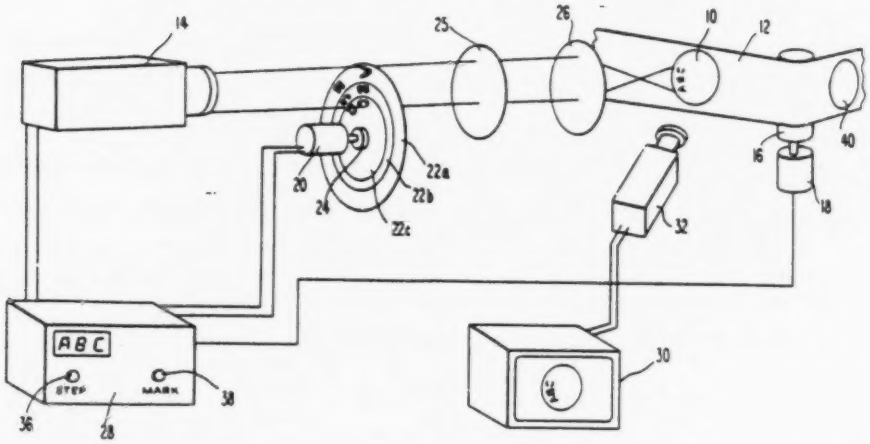
Primary Examiner—John K. Corbin
Assistant Examiner—Scott J. Sugarman
Attorney, Agent, or Firm—Frank C. Parker; Ronald L. Lyons

[57] **ABSTRACT**

Indicia are formed in the surface of an ophthalmic contact lens by sublimating lens material with a high intensity beam of radiation. A beam of light from a laser is directed through one or more cooperating masks having openings defining desired indicia. The light which passes through the masks is directed upon a surface of a contact lens, advantageously near the periphery thereof. By selecting a proper wavelength and controlling the amount of energy directed upon the lens surface the depth of sublimation of lens material can be controlled. In this manner symbols can be formed upon the lens for uniquely identifying it.

10 Claims, 3 Drawing Figures



U.S. Patent Mar. 25, 1980 Sheet 1 of 3 4,194,814

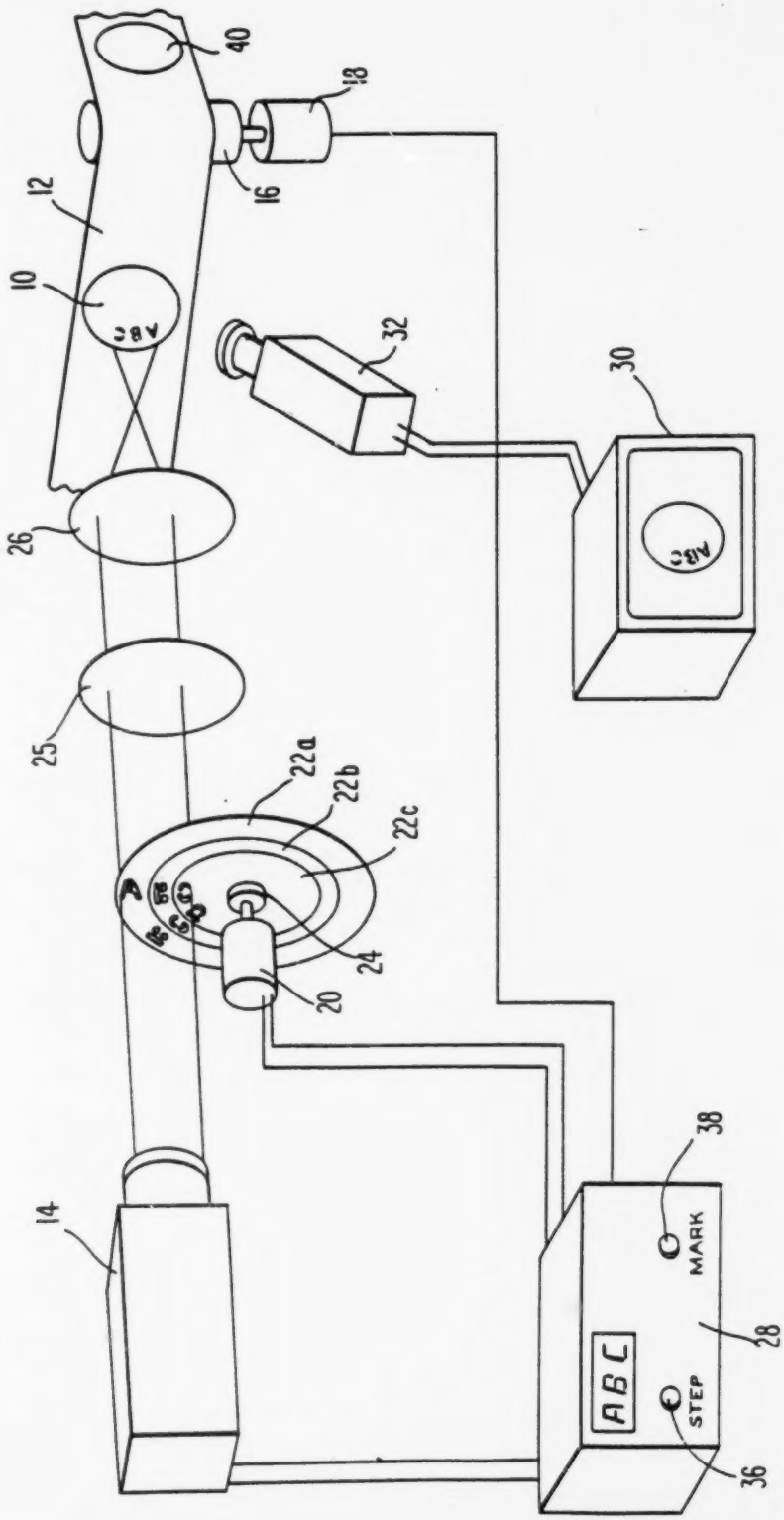


Fig. 1

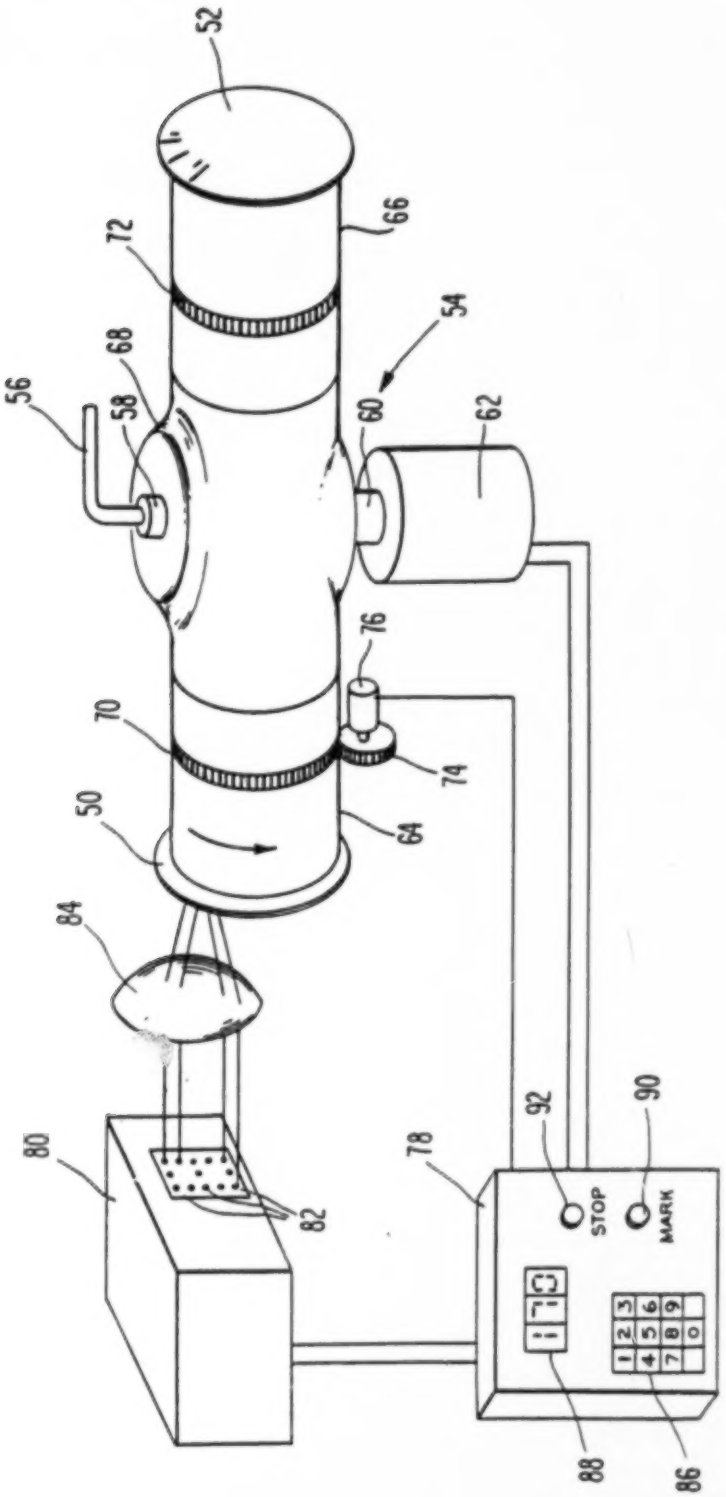

52
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Fig. 2

U.S. Patent Mar. 25, 1980 Sheet 3 of 3 4,194,814

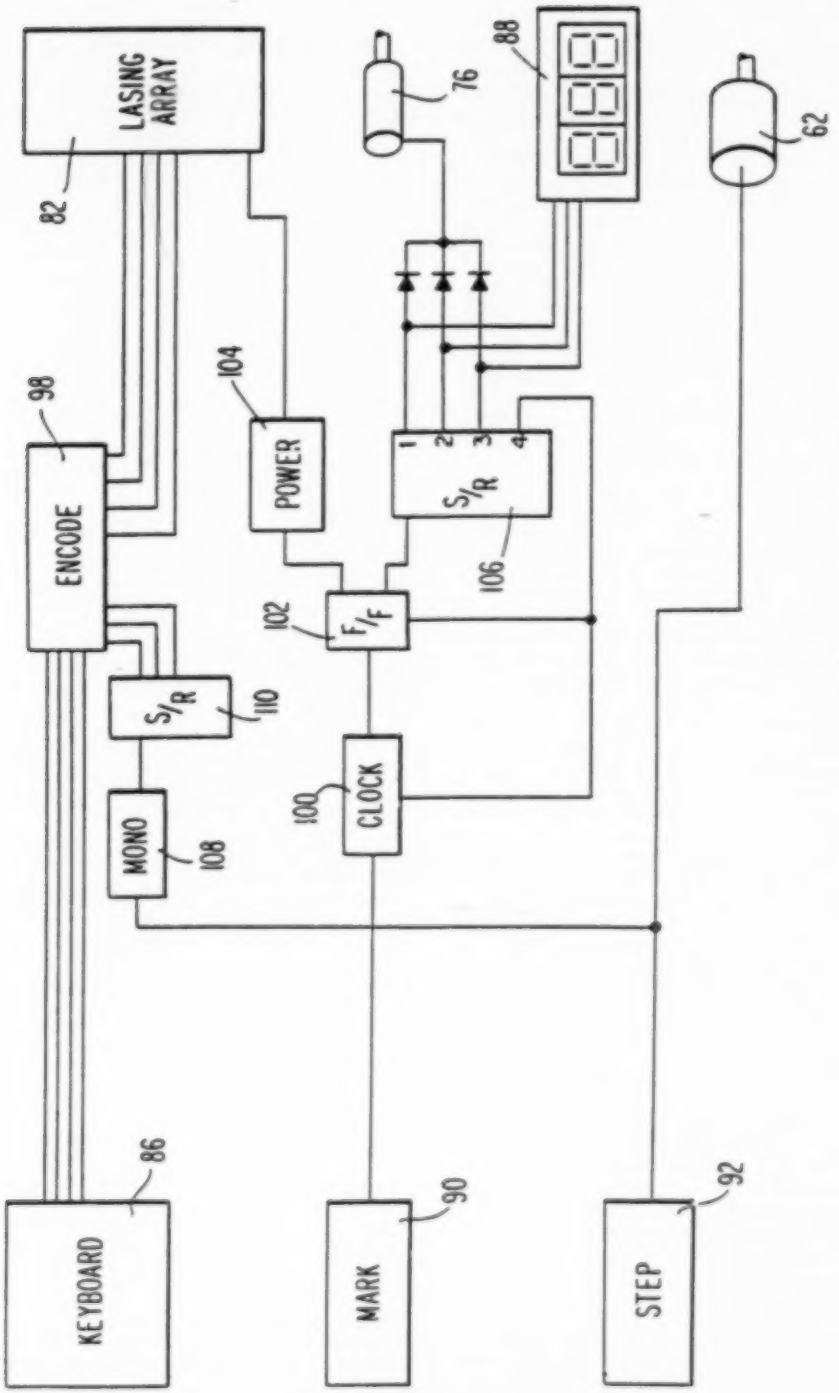

Fig. 3

02-22-80 203834 78147 0 04194814 2137

TRANSPARENT OPHTHALMIC LENS HAVING ENGRAVED SURFACE INDICIA

BACKGROUND OF THE INVENTION

The present invention relates to ophthalmic lenses adapted for direct contact with eye tissue, and more particularly to procedures for forming identifying symbols upon such lenses.

It has long been known that the vision of the human eye can be aided by disposing a small, transparent lens directly upon the surface of the eye, the contours of the lens supplementing and correcting the effect of the biological lens within the eyeball. In recent years the materials and techniques for manufacturing such lenses have improved markedly, with the result that contact lenses are being worn in ever-increasing numbers. Certain recent advances in contact lens technology, particularly the introduction of the so-called "soft" contact lens, has led to still further popularity of contact lenses. Unlike the well-known "hard" contact lens, the soft lens is relatively pliable, particularly when it is in use and hydrated.

Certain problems inhere in the use of contact lenses. Of particular interest is the difficulty in uniquely identifying lenses. With the aid of specialized intrumentation the optical qualities of a given contact lens may be measured, and thus in some respects a lens may be identified. However, in the broad sense it is difficult to uniquely identify lenses inasmuch as they are relatively small and look substantially alike even under mangification.

The ability to identify individual lenses, though it would be extremely useful to lens wearers and to ophthalmologists and opticians, has so far eluded the industry. It would, for instance, be extremely useful for a wearer to be able to differentiate between lenses for left and right eyes. Still further, it would be essential to identify lenses in the event they are accidentally commingled. This could occur at various stages during their manufacture, shipment or preparation in the office of a fitter. In addition, it would in many cases be extremely useful to be able to identify the manufacturer, material lot, and production run of a given lens; and finally to be able to identify the optical characteristics of a lens without actually measuring them.

A number of solutions have been suggested, and in some cases experimented with. For instance, identifying characters could be imprinted upon the surface of the lens. This approach, however, requires the application of a separate material to the lens with the accompanying danger of its separation therefrom. Further, inasmuch as some contact lenses are subject to rigid governmental requirements, the addition of extraneous materials would require lengthy testing and qualification procedures.

It has further been suggested that identifying indicia be machined or mechanically etched into the surface of a contact lens. While this approach has been tried, it has met with little success due to the difficulty of physically machining or scratching marks into the surface of the lens with conventional apparatus. The difficulty in actually machining the surface of the lens with miniscule tools is apparent, although some efforts have been made to scratch symbols into a lens surface using a pantograph.

For all of the foregoing reasons, it will be appreciated that there is a need for an improved method for applying identifying indicia to contact lenses, which does not require the addition of extraneous material to the lens itself and which is economically feasible.

It is therefore an object of the present invention to provide a method of applying identifying indicia to contact lenses.

Another object is to provide an improved method for etching symbols into the surface of an ophthalmic contact lens.

A further object is to provide a system for reliably and uniquely applying identifying indicia to sequentially-presented contact lenses.

Yet another object is to provide a contact lens having identifying indicia formed by the impingement of a high-energy beam of light that interacts with the lens material.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention, the foregoing objects are achieved by providing a source of high intensity electromagnetic energy, preferably a laser, which produces electromagnetic energy at a specified wavelength and of an predetermined intensity. A eye contacting lens to be marked is then disposed in the path of the beam of electromagnetic energy from the high intensity source, and appropriate means (such as a suitable mask, for example) are provided to cause the beam to impinge upon the lens surface in a preselected pattern. The laser beam is then briefly applied to the lens surface in this preselected pattern in a manner such that the beam which impinges upon the lens surface sublimates or vaporizes the lens material to a controlled depth and provides the desired markings in the lens surface.

In a preferred embodiment, automated means are used to sequentially vary the configuration of a mask in synchronism with the presentation of successive contact lenses in the high intensity electromagnetic energy path. Alternatively, an array of high intensity energy sources, such as lasing diodes, for example, are provided and selectively energized to direct a predetermined pattern of high energy light upon the surface of the lens.

In accordance with the invention, it has unexpectedly been discovered that preselected portions of a contact lens surface may be sublimated or vaporized to form identifying indicia in the surface despite the fact that the lens itself is transparent and is provided with a polished surface. By selecting the proper energy wavelength and intensity the surface of a contact lens may be marked to a controlled, limited extent and the markings so made, although extremely small, can be visually perceived either with or without the use of optical aids, thereby facilitating an identification of the lens.

It has also been discovered that little if any proteinaceous material accumulates in the craters which constitute the marks formed in the lens surface. Such material as does accumulate is readily removed by normal lens cleaning procedures. Furthermore, the edges of the craters neither inflame nor irritate the eyelid of the lens wearer. The markings provided on the lens surface in accordance with the invention if restricted to the non-corrective portions of the lens, e.g. near the lens periphery, are not perceived by the lens wearer and do not affect or interfere with his visual acuity.

In accordance with the invention the wavelength and intensity of the electromagnetic energy, such as, for

example, a laser beam, is selected to rapidly sublimate or vaporize predetermined areas of the lens material, thereby to provide the desired identifying indicia in the lens surface. As will be appreciated by those skilled in the art, values of energy wavelength and intensity are selected which will not pass through the lens, but instead will vaporize or sublimate the material to a depth that can be controlled by regulation of the period of exposure of any predetermined area of the lens surface to the high energy radiation. The particular wavelength, intensity of radiation and period of its application to a preselected location on the lens surface may be established for any particular material by routine experimentation. Thus, for example, a soft, hydrated contact lens formed of a hydrophilic polymer such as, for example, that disclosed in U.S. Pat. No. 3,721,657, was successfully marked utilizing a model 901 laser of the helium-CO_2-nitrogen type manufactured by Lumonics Research Ltd. Of Ontario, Canada, which emitted light at a wavelength of about 10.6 micrometers for bursts of about one microsecond. An energy concentration of from 1 to 3 Joules per square centimeter at the surface of the lens target was found to be suitable. The depth of the marking in the surface in the lens was of the order of 0.01 mm. As will be appreciated by those skilled in the art, higher energy densities or repeated applications of bursts of energy to a preselected location at the lens surface will vaporize or sublimate the lens material to a greater depth. In this regard, it was unexpectedly discovered that successive applications of bursts of energy resulted in progressively less penetration of the target lens in each succeeding burst. Preferably, therefore, the energy density of the laser beam and the period of its application are adjusted so that marks having a sufficient depth may be formed without the necessity of applying repeated bursts of energy of any one preselected location on the lens surface.

In general, any eye contacting lens, corneal or scleral, may be marked in accordance with the present invention. Included among the lenses that may be so marked are the "hard" lenses such as those formed of glass as well as those described, for example, in U.S. Pat. No. 3,221,083—Crandon (lenses formed of allyl diglycol carbonate cured with a vinyl-type monomer, such as maleic anhydride or glycidyl methacrylate); and U.S. Pat. No. Re. 29,229 (lenses prepared from polymers of hexafluoroacetone-tetrafluoroethylene-ethylene, or of perfluoroalkylethyl methacrylates or of perfluoro-2-methylene-4-methyl 1,3 dioxolane); "soft" or hydrophilic lenses such, for example, as disclosed in U.S. Pat. No. 3,721,657 (hydrophilic lens formed of a copolymer of vinyl pyrrolidone and hydroxy-ethylmethacrylate cross-linked with diethylene glycol dimethacrylate); and organometallic lenses such, for example, as disclosed in U.S. Pat. No. 3,959,102 (lens formed of a cross-linked graft copolymer of a polyorganosiloxane and polyvinyl pyrrolidone); U.S. Pat. No. 3,228,741 (lens fabricated from transparent silicone rubber); and similar silicone polymer, resin or rubber materials. The soft or hydrophilic lenses, such as disclosed in U.S. Pat. No. 3,721,657, for example, may be marked in accordance with the invention either prior or subsequent to hydration. In this connection, it has been discovered that although the parameters (i.e., wavelength and intensity, period of application) of the electromagnetic energy directed to the hydrated lens must be adjusted to compensate for the degree of hydration, the requisite degree of vaporization or sublimation of the lens material occurs despite the presence of water in the lens.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention, it is believed that the invention will be better understood from the following description of a preferred embodiment taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates one system for applying indicia to contact lenses;

FIG. 2 illustrates another form of apparatus, adapted for applying indicia in serial fashion to a contact lens surface; and

FIG. 3 is an example of one form of control system for use with the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to FIG. 1, an eye contacting lens 10 mounted upon a conveyor 12 is brought into registration with a beam of energy originating at a laser 14. The conveyor is engaged by a roller 16 or the like, coupled to a driving mechanism such as a stepping motor 18. A second stepping motor 20 is coupled to a series of apertured masks 22*a*-22*c* through an appropriate drive mechanism 24. A filter 25 is disposed in the path of the beam to afford depth control, and a positive lens 26 is provided to concentrate the light passing through masks 22*a*-22*c* upon the surface of lens 10.

Focusing means 26, generally illustrated as a conventional optical lens, must be formed of an appropriate material, such as germanium for use with infrared lasers. Alternatively, a focusing mirror may be used in place of a lens. In view of the wavelength of the light emanating from laser 14, to be discussed hereinafter, the focusing means is advantageously formed of a material which is transparent to and refracts the wavelength utilized. Masks 22*a*-22*c* may be formed of any material which is opaque to the laser beam and which may be worked with sufficient precision to form a clean, well-defined opening. A mask formed of thin bronze or beryllium has been found to work well in practice.

A control 28 is provided for operating laser 14, and for energizing stepping motors 18, 20 at appropriate times. Finally, a television receiver 30 is coupled to a camera 32 for monitoring operation of the system.

While many types of lasers may be adapted for use with the present invention, a successfully-tested embodiment utilized a Model 901 laser of the helium-CO_2-nitrogen type manufactured by Lumonics Research Limited of Ontario, Canada. As will be more fully discussed hereinafter this laser produces a beam of light energy at a wavelength which effects sublimation of cross-linked polymeric material including both dry (anhydrous) and water-bearing (partially or fully hydrated polymers. It will be appreciated that other types of high-intensity sources which produce sufficient concentrated radiant energy for sublimating the surface of a contact lens may be used. Accordingly, the term "high intensity light energy" as is used herein denotes rediant electromagnetic energy which is of a proper wavelength and is sufficiently concentrated to sublimate contact lens material.

In accordance with the present invention it will now be appreciated that it is possible, using the proper en-

ergy wavelength and intensity, to sublimate selected portions of the lens surface to form identifying symbols and the like. This may be accomplished by using a laser emitting a wavelength in the infrared band to mark the highly polished lens. It has been discovered that the surface of a contact lens can be successfully sublimated to a limited depth and further that markings thus made, although of extremely small dimensions, can be visually perceived, albeit often with the use of optical aids.

Further, although it is understood that previous attempts to laser-mark wet or water-bearing materials have been unsuccessful it has been discovered that satisfactory marking of soft contact lenses can be achieved both before and after hydration.

Soft lenses may be formed by a polymerization process such as disclosed in U.S. Pat. No. 3,721,657 and formed into lens blanks by the method described in U.S. Pat. No. 3,221,083—Crandon. The hard lens blanks are cut and polished to the desired contours and then placed in a fixture, such as conveyor 12 of the drawing. An appropriate mask or group of masks is then assembled over the lens surface. After the focusing means 25 is interposed in the radiation path between the mask and the lens surface, laser 14 is energized to direct a beam of concentrated energy upon the lens surface.

The laser energy, being of a wavelength as described above, impinges upon the lens material and immediately vaporizes or sublimates the material. When the burst of energy ceases the lens material ceases to sublimate, leaving well-defined craters or sets of grooves in the lens surface and corresponding to the form of the masks selected. Despite the fact that the process generates sufficient heat to vaporize the lens material the edges of the symbols are not jagged or ridged but rather are rounded and smooth. Further, the sides and bottom of the grooves formed by sublimation are typically frosted, or at least translucent. It is this characteristic which, in part, detracts from the effectiveness of successive laser bursts, due, it is believed, to a scattering effect upon the incident light energy, and to the fact that energy is by design, focused at the surface of the target lens.

In general, any contact lens may be marked in accordance with the present invention, the only requirement being that electromagnetic radiation of the proper wavelength be used to effect the desired vaporization or sublimation of the lens material.

While the specific type of masking means used in the practice of the present invention is not critical, masks of beryllium have been found satisfactory. In the embodiment of FIG. 1, the beryllium masks have apertures formed therein in the shape of alphanumeric characters, although other identifying symbols may also be used. Further, the illustrated embodiment contemplates the use of a series of concentric masks which are sequenced through an appropriate gear drive. Accordingly, mask 22*a* defines the leftward-most character, herein "A". The next inner mask 22*b* is aligned so that the character "B" is next to "A". Finally the innermost mask 22*c* is oriented to present the character "C" radially inwardly of the first two characters. In this manner three characters at a time may be presented in the path of the beam.

By providing appropriate control means, such as a one-shot timer for example, within control 28, depression of button 36 will allow a timed pulse to energize stepping motor 20 for a predetermined period. Accordingly, the motor 20 operates through gear box 24 to rotate disks 22*a*-22*c* in the proper sequence so that the set of characters is incremented, for instance from ABC to ABD. Of course, the selection of characters is arbitrary and the number and format of the characters can be selected for any given application.

The light which is allowed to pass through the masks ("spatially filtered") is then passed through filter 25 and lens 26 which concentrates and focuses the beam onto lens 10. Preferably the beam is focused near the periphery of the lens, on the generally annular non-corrective zone which does not overlie the pupil. In this manner the indicia will not interfere with the vision of the lens wearer.

By pressing button 38 labeled "MARK" the control 28 energizes laser 14, whereupon a high-energy beam of light is transmitted through the masks and lens 26, impinging upon the surface of target lens 10 as described. The impingent radiation vaporizes or sublimates the material of the lens in a pattern corresponding to the openings in masks 22*a*-22*c* so that the legend "ABC" is formed in relief upon the lens surface. This activity is monitored by means of television camera 32, having appropriate optics for magnifying the image of lens 10 so that faults can be detected and the lens corrected or discarded as appropriate.

Upon pressing STEP button 36 a second function is implemented. In addition to incrementing the alphanumeric display formed by masks 22*a*-22*b*, stepping motor 18 is energized for a predetermined period to cause the transport mechanism to bring a succeeding lens blank 40 into registration with the path of the beam from laser 14. The system then maintains its position as an operator causes laser 14 to project a pulse of high intensity light energy through the newly-incremented masks, and onto an appropriate area of the lens.

The advantages of the above-described method are manifold. Firstly, while the indicia formed are substantially translucent they can easily be seen, for instance by side lighting, with simple optical magnifying apparatus. No foreign substance whatever is introduced to the lens; its chemical composition remains unchanged. No protrusions or irregularities are formed on the lens surface which would tend to abrade or irritate eyelid tissue, and moreover the marked lens is readily subjected to all of the usual hygienic regimens necessary for both hard and soft type lenses. The markings are eminently durable, not being prone to being worn off or abraded through use, and cannot flake off as would be the case with applied coatings. Moreover, the process described is ideally suited for high-volume production inasmuch as lenses need only be mounted upon an appropriate transfer mechanism and a mask assembly placed in proper alignment with the beam of high intensity light. No tooling, scribers, or chemically-resistant masks need be applied directly to the lens surface and the resolution of the characters is limited only by the quality of lens material and the wavelength of light used. Accordingly extremely small, high-resolution characters may be selected. Finally, by using indexible masks the nature of the markings can readily be automatically incremented without the need for replacing entire mask assemblies, or attempting to register miniature masks directly upon the lens surface as is the case with chemical etching processes.

FIG. 2 depicts another embodiment of the present invention wherein an automatic indexing arrangement allows characters to be formed, one at a time, upon the face of a contact lens. Contact lenses 50 and 52 are disposed upon each end of a lens holding fixture gener-

ally indicated at 54. Opposing ends of the fixture are configured to generally match the inner or convex surface of a lens, and are provided with passages extending outwardly through fitting 56 by way of rotatable sealing member 58. Accordingly, by drawing a vacuum through fitting 56 lenses will be securely held upon the ends of the fixture. The fixture is journaled upon a shaft 60, which is coupled in turn to a stepping motor 62. Arms 64,66 of the fixture are rotatably journaled to a center protion 68 and provided with engaging areas 70, 72 which frictionally and/or mechanically engage mating teeth or notches upon a drive wheel 74. The latter is in turn driven by means of a second stepping motor 76. Both stepping motors 62 and 76 are operated by means of a master control 78 which may be operated either automatically, or semi-automatically by an operator.

Also operated by means of master control 78 is a power source 80 for an array of high intensity light emitting diodes 82. In the present embodiment, light emanates from a plurality of the diodes which are arranged in an appropriate configuration. In FIG. 2 the configuration for the diodes corresponds generally to the familiar 7-bar display; however, it will be recognized that the diodes may be arrayed in any desired configuration, depending upon the nature of the characters to be formed. Furthermore, this approach allows selection of specific combinations of wavelengths for maximizing interaction with different materials. If a lens material is transparent to one wavelength, another wavelength can be selected which interacts with the material. Each diode has its own characteristic wavelength. A lens 84 is interposed between the diodes and the contact lens 50 for concentrating and focusing the light emitted by the diodes upon an appropriate portion of the target lens 50.

In operation, an operator presses appropriate setting buttons 86 to cause the desired set of symbols to appear in readout window 88. Alternatively, a simple counter assembly within the master control may be used to increment the display automatically. This determines the characters, and the sequence thereof, which will be produced by selective energization of diodes 82. When the "MARK" control button 90 is depressed appropriate combinations of diodes 82 are energized for forming the first character of the desired display; in the present illustration, the numeral 1. Light energy from the diodes which are energized then traverses lens 84 and is focused upon the periphery of contact lens 50, sublimating the lens material to a controlled depth of 0.01 to 0.1 mm. Immediately thereafter, the diodes are deenergized and stepping motor 76 is operated to index member 64 about in the direction indicated. Indexing is quite short, being sufficient to move the previously-formed character from the field of the diode display so that a second character (in the present illustration the numeral "7") may be formed. Upon completing the indexing operation, as may be determined by a simple timer arrangement, an array of diodes corresponding to the second numeral "7" are energized. As before, the intensified light energy is concentrated and focused by means of lens 84 and impinges upon the surface of contact lens 50 to form the next character. As the diodes are deenergized stepper motor 76 again operates, and the process continues until all of the desired characters are formed along an arcuate locus near the periphery of the contact lens.

During the foregoing operation an operator or an automated machine element removes the lens from

support 66 and places a new lens element thereon. In this manner when marking of one lens is completed, the apparatus 54 may be indexed around 180° by pushing STEP button 92. This energizes stepping motor 62 and brings the opposite end of the fixture into registration with the path of the diode light beams.

Of course, a plurality of lens-holding elements may be provided, the illustrated embodiment being only exemplary of a presently-preferred embodiment. However, through the use of the automatic stepping and indexing arrangement herein depicted it will be apparent that a single source of character-defining energy may be used. Further, while diodes are disclosed in the embodiment of FIG. 2, it is contemplated that alternative light sources, or a single light source coupled with an adjustable mask arrangement, can be substituted. The array can alternatively be constituted by fiber optic strands used in conjunction with a single light source, or by any other appropriate means of arraying the light energy in a desired pattern.

FIG. 3 illustrates one example of a control system for operating the automated lens marking apparatus of FIGS. 1 and 2. While the specific system shown is specifically intended for controlling the system of FIG. 2, it will become apparent to those skilled in the art that it can be readily adapted for use with the system of FIG. 1.

Appropriate members of keyboard 86 are first depressed to select a desired set of characters. Impulses from the keyboard are transmitted to a coding state 98 which in turn is connected to the array of lasing diodes 82. Coding stage 98 thus determines which of the arrayed diodes are to be energized. When MARK switch 90 is operated it initiates a counter or clock 100, which in turn operates a bistable element such as flip-flop 102. The flip-flop alternately energizes power stage 104 and a shift register or similar counter element 106. As register 106 is incremented alternately with energization of the lasing array by means of power stage 104, the stepping motor 76 is chosen to index the target contact lens about to present successive imprinting regions to the path of the laser beams. Display 88 is responsive to the state of coding stage 98, and provides visual indication and verification of the characters selected.

With the illustrated embodiment three characters are presented, so that stepping motor 76 is operated in response to the energization of the first three outputs of shift register 106. When the fourth register output is energized the signal is fed back for resetting flip-flop 102 to preclude subsequent energization of the lasing diodes. Additionally, the signal is applied to clock 100 for disabling the latter at which time the indicia forming operation is completed.

As set forth above, the next step is for an operator to depress STEP button 92 whereupon stepping motor 62 is operated for indexing the lens-bearing fixture about to present a fresh lens to the marking apparatus. In a preferred embodiment the STEP signal is also applied to a monostable circuit 108 which operates shift register 110 to automatically increment the coding stage 98 so that the next successive one of a series of characters is selected. Alternatively, selection of an appropriate character for each individual contact lens could be made by depressing appropriate buttons of keyboard 86.

Upon gaining an understanding of the present invention it will readily become apparent that appropriate control systems of various types can be devised, using conventional techniques and system components. Ac-

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cordingly, it should be understood that various other controls may be implemented without departing from the teachings of the invention.

Illustrated near the periphery of contact lens 32 in FIG. 2 are a set of characters of binary nature. It is recognized that characters other than the generally-recognized alpha-numeric characters may be selected for use. Particularly where extremely small characters are used it may be desirable to provide only two character forms in order to preclude confusion. Further, the two-form or binary characters contemplated also facilitate automated or machine reading. The term "binary characters" as used herein refers to any sort of marking scheme in which two distinct characters are used to represent information in coded fashion. In this context long and short lines, large and small dots, or combinations of lines and dots as shown in FIG. 2 may be used. The invention is, however, extremely well adapted for use with any font or set of symbols which may be desired.

Further, inasmuch as the characters are formed by a beam of light their resolution can be made extremely high, and the size or aspect ratio of the display easily manipulated by standard optical means, such as lenses or mirrors.

In accordance with the above, it will now be appreciated that there has been disclosed a means and method for rapidly and efficiently applying permanent markings to ophthalmic contact lenses in a manner which provides excellent registration and repeatability, and avoids problems inherent in prior art approaches wherein chemical compositions of lenses were changed in localized areas, or foreign materials applied to the lens.

As will be evident from the foregoing description, certain aspects of the invention are not limited to the particular details of the examples illustrated, and it is therefore contemplated that other specifications or applications will occur to those skilled in the art. It is accordingly intended that the appended claims shall cover all such modifications and applications as do not depart from the true spirit and scope of the invention.

What is claimed is:

1. An ophthalmic lens adapted to be placed in direct contact with eye tissue formed of a transparent cross-linked polymer material, said lens being characterized by identifying indicia engraved in a surface thereof by subjecting said lens to a beam of radiation emerging from a laser having an intensity and wavelength at least sufficient to sublimate said polymer and form depressions in said lens surface to a depth less than the thickness of said lens, said lens having a smooth surface of unsublimated polymer material surrounding said depressions, and by varying in a predetermined manner the point at which said laser beam impinges upon said lens surfaces to engrave said identifying indicia in said lens surface.

2. A contact lens according to claim 1 wherein said lens is formed of a cross-linked hydrophilic polymer.

3. A contact lens according to claim 1 wherein said lens is formed of a cross-linked hydrophobic polymer.

4. A contact lens according to claim 1 wherein said lens is formed of an organo-metallic polymer.

5. A contact lens according to claim 2 wherein said lens is hydrated.

6. A contact lens according to claim 1 wherein said lens is formed of silicone polymer, resin, or rubber.

7. An article of manufacture comprising a soft lens adapted for disposition in direct contact with eye tissue formed of a transparent crosslinked polymer material and having a plurality of relieved zones formed in a surface thereof, said relieved zones being formed by the process of:

providing a source of high intensity electromagnetic radiation of a wavelength which will be absorbed by the lens material;

forming said radiation into a beam having a cross-sectional shape which corresponds to the shape of the desired relieved zones; and

applying said beam of radiation to a surface of said lens for a predetermined period to effect sublimation of lens material in said zones to a depth less than the thickness of said lens material;

whereby relieved zones of the desired shape are formed, and whereby said surface of said lens surrounding said relieved zones is smooth and unaffected by said radiation.

8. An article according to claim 7, wherein said zones define coded characters.

9. An article according to claim 8, wherein said zones define at least one alphanumeric character.

10. An article according to claim 8, wherein said zones define at least one binary character.

* * * * *

Plaintiff's Trial Exhibit 27
pp. 1, 17-19, Deposition of D. Brucker

UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

C-83-20283-WAI (SJ)

BAUSCH & LOMB INCORPORATED, a corporation,
Plaintiff.

vs.

BARNES-HIND/HYDROCURVE, INC., a corporation and BARNES-HIND INTERNATIONAL, INC., a corporation,
Defendants.

Deposition of
DONALD BRUCKER, O.D.

Deposition of Donald Brucker, O.D., a witness herein, taken by plaintiff pursuant to the applicable sections of the Federal Rules of Civil Procedure, on Tuesday, March 27, 1984 before Kathryn B. Martin, CSR No. 3079, a Notary Public, at San Diego, California.

Q. Have you had any experience with the application of lasers to lenses? A. Yes.

Q. When did that experience commence? A. I don't remember exactly. It was in the early seventies.

Q. And what initiated your interest in applying lasers to lenses? A. I thought it would be a good way to fenestrate a contact lens.

Plaintiff's Trial Exhibit 27
pp. 1, 17-19, Deposition of D. Brucker

Q. Would you explain what you mean by "fenestrate a contact lens." A. It means drill a hole in the lens. Until that time the holes—this was done to allow tears to flow from underneath the lens, and up to that time microdrills were used for fenestrating lenses, and they were—the same drills that were used for marking the lens were used for fenestrating.

Then we—the problem with drilling was that it was somewhat crude and especially for fenestrations, didn't leave smooth surfaces and they were hard to polish. I thought fenestration would leave a smoother surface on the lens in the hole.

Q. Okay. So how did you set about trying to experiment with lasers? What did you do? A. Well, I contacted a laser company and hired a consultant. And we tried various lasers. I believe we—again, this is—I haven't refreshed my memory at all on this, so this is ten-year-old information or more than that.

I believe it was a CO_2 laser. We found one that we felt would make a smooth hole or a smooth mark on the lens. And then I hired someone to make a device so that we could index the spacing on the laser holes that were put in the lens. And we developed that and then patented it.

Q. Now, you said you thought it would make a smooth hole or a smooth mark on the lens. Were you looking at that time to mark as opposed to fenestrate? A. Primarily to fenestrate.

Q. Well, were you looking to mark at all? A. We did mark. At that time the only reason for marking a lens that

Plaintiff's Trial Exhibit 27
pp. 1, 17-19, Deposition of D. Brucker

was of any use was to mark right from left. We are talking about hard lenses at the time. And because we didn't—normally didn't want to have to inventory lenses in such a way, we weren't particularly interested. But in studying what we were doing, we—if we used too much laser, we would get a large kind of uncontrolled hole. If we didn't use enough, we would just get a mark on the lens. So we had to be careful to control the power of the impulse in order to get the hole through the lens.

Plaintiff's Trial Exhibit 28, Caddell Patent No. 3,549,733

Dec. 22, 1970 J. R. CADDELL 3,549,733

METHOD OF PRODUCING POLYMERIC PRINTING PLATES

Filed Dec. 4, 1968

FIG. 1

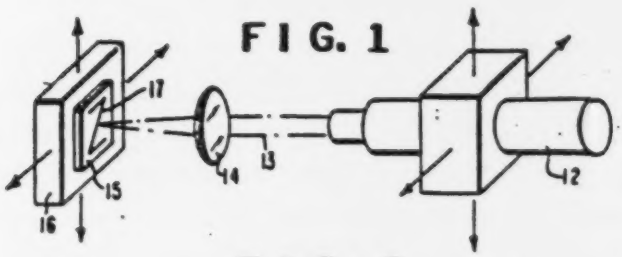


FIG. 2

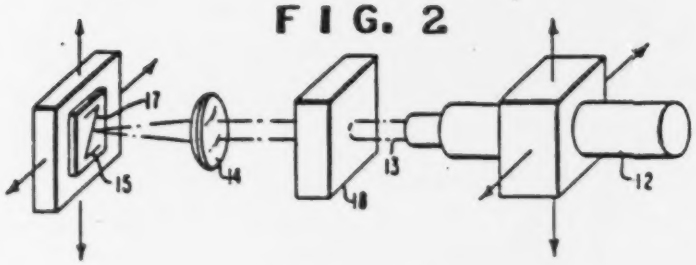


FIG. 3

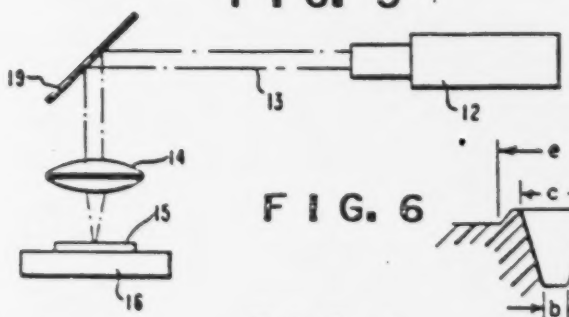


FIG. 6

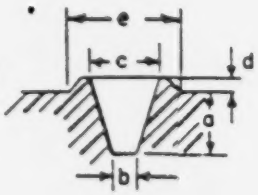


FIG. 4

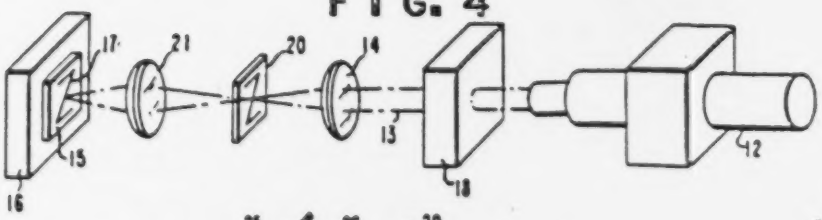
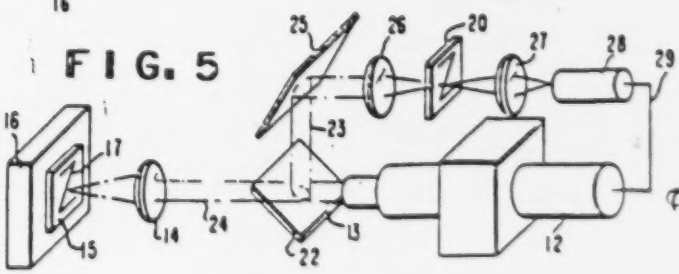


FIG. 5



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United States Patent Office

3,549,733
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3,549,733

METHOD OF PRODUCING POLYMERIC PRINTING PLATES

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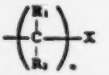
Int. Cl. B29c 17/08
U.S. Cl. 264—25 23 Claims

ABSTRACT OF THE DISCLOSURE

A method for producing a polymeric printing plate by subjecting a plate, the surface of which is uniformly and substantially composed of a solid polymer selected from the group consisting of homopolymers of a unit and copolymers having a substantial number of units of the general unit formula:



where n is an integer having a value of at least one, X is selected from the group consisting of sulfur and oxygen, and R_1, R_2 are each selected from the group consisting of H, F, Cl, CF_3 and CCl_3; to a controlled laser beam of sufficient intensity to decompose the polymers and form depressions in the surface of the plate. The depth of the depression can be selectively varied by modulating the intensity of the incident laser beam, and the pattern engraved in the surface can be controlled by moving the plate or the laser, by deflecting the laser beam, or by placing a mask or transparency between the laser and the plate.

BACKGROUND OF INVENTION

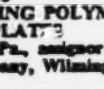
There are numerous ways to engrave the surface of a material. The effectiveness of a particular technique, however, depends on the type of material to be engraved and the proposed use for the engraving. In the printing industry with its tremendous output, for example, the simplest method—hand engraving—is much too expensive and time consuming to be widely used. Also, hand engraving usually results in ridges being formed around the engraved region which renders the engraving unacceptable for use as printing plates because these ridges trap ink which eventually builds up to the point where it smears or blurs the printed image. Consequently, printers have almost universally adopted chemically etched metal printing plates. These plates still require excessive time and effort to produce, however, and are often irregular because of the uncontrollability of the etching process.

The present invention relates to a method for making printing plates by engraving the surface of a polymer with a laser beam. Such plates can be made quickly and inexpensively, and because of the precision with which laser beams can be controlled, sharp engravings can be produced. Since laser engraving of any material, particularly a polymer, generally proceeds by melting and results in depressed areas surrounded by ridges, the material to be engraved and the conditions under which the engraving is to take place must be carefully selected if the engraved plate is to be useful as a printing plate.

SUMMARY OF INVENTION

In the present invention a printing plate is produced by subjecting a plate the surface of which is uniformly and substantially composed of a solid polymer selected from the group consisting of homopolymers of a unit and

copolymers having a substantial number of units of the general unit formula:



where n is an integer having a value of at least one, X is selected from the group consisting of sulfur and oxygen, and R_1, R_2 are each selected from the group consisting of H, F, Cl, CF_3 and CCl_3; to a controlled laser beam of sufficient intensity to decompose the polymers and form depressions in the surface of the plate. The process is operable even if the polymer contains a small amount of impurity, and in some cases, the process is operable even if the polymer is not of the group specified if the polymer is filled with between 20 to 50% by weight of fiber glass or rutile composition. The depth of the depression can be selectively varied by modulating the intensity of the incident laser beam, and the pattern engraved in the surface can be controlled by moving the plate or the laser, by deflecting the laser beam, or by placing a mask or transparency between the laser and the plate. In some instances when the laser would destroy the mask the laser beam can be split, one part being used to engrave the surface of the polymer, and the other being used to monitor the surface of a mask and control the first part in conformance with the monitored signal.

For a better understanding of the present invention reference is made to the following figures:

FIG. 1 is a schematic diagram of one possible embodiment of an apparatus that can be used to produce a printing plate;

FIG. 2 is a schematic diagram of another possible embodiment of an apparatus that can be used to produce a printing plate;

FIG. 3 is a schematic diagram of a third possible embodiment of an apparatus, including scanning means, which can be used to produce a printing plate;

FIG. 4 is a schematic diagram of a fourth possible embodiment of an apparatus which can be used to reproduce the image of a template or a transparency on a printing plate;

FIG. 5 is a schematic diagram of a fifth possible embodiment of an apparatus which can be used to reproduce the image of a template or transparency on a printing plate, and

FIG. 6 is a cross-section diagram of the type of depression that a device such as that of FIG. 1 will produce in a plate.

DISCUSSION OF THE DRAWINGS

In FIG. 1, laser 12 produces a beam of coherent radiation 13 which is focused by lens 14 onto the surface of a polymeric sample plate 15 which rests on support stage 16. Either the laser or the support stage can be adapted to move in a controlled manner so that the beam of focused radiation can be made to engrave the desired trace in the surface of the sample plate.

The choice of laser depends largely on the necessary energy content or intensity of the beam. Almost any solid state, liquid or gaseous laser can be used. The CO_2 laser is particularly suitable because of its high level of efficiency and its high intensity output. The laser can be adapted to emit either a pulsed or continuous wave (CW) beam. If the laser emits a CW beam, the energy incident on a particular portion of the sample can be varied by either varying the output of the laser, or by varying the rate at which the laser beam moves relative to the sample. For many types of lasers, however, high intensity output is not possible under CW operation. Such lasers are often operated in a pulsed mode. Even if a laser cap-

able of CW operation is used, a pulsed beam may be desirable. Such a beam can be produced by chopping the laser beam with a chopping device 18 placed between the laser and the plate as shown in FIG. 2. This chopper can be a slotted rotating disc, a Kerr cell, or any other chopping device known to those skilled in the art. Alternatively, the laser itself can be pulsed by a method such as Q-switching. If a pulsed beam is used, the energy incident on a particular portion of the sample can be varied by varying the output of the laser, the rate and duration of the pulse, or the rate at which the laser beam moves relative to the sample. The particular details of the laser light source are not given since these sources are well known to those skilled in the art. One suitable laser is Model 40 CO_2 gas laser manufactured by Coherent Radiation Laboratories.

Lens 14 is illustrated as a refracting lens. It should be apparent, however, that a reflecting and focusing mirror could be used in place of the lens if desired. In any event, the focusing device can be of either fixed or variable focus. If a lens is used, the lens must be transparent to the wavelength of the laser beam, otherwise absorbed energy will cause discoloration and perhaps cracking of the lens material. One suitable lens for use with the laser designated above is Model LS-20 (2½ inch effective focal length) made by Coherent Radiation Laboratories.

The present invention can be used to engrave a surface of any convenient shape. In all of the discussion this surface is referred to as a plate, which connotes flatness, but the term is used in the sense of a printing plate, which can include a gravure cylinder or a surface of almost any shape. The surface of the plate is uniformly composed of the materials discussed below. By this it is meant that the plate is normally composed of a single material throughout. In some cases, where greater stability is required, the plate can be a composite of one of the polymeric materials discussed below on a suitable backing, such as metal. If such is the case, the thickness of the polymer must be such that the laser doesn't burn through the coating. The entire depression is to be contained in the polymeric surface.

The term engraving generally means to form a depressed area in the surface of a material. It should be apparent that the procedure described herein is also applicable to drill a hole directly through the material, or to etch away a surface material to expose a layer of a different material below. In this discussion the term engrave shall be construed to include all such possibilities. The distinguishing feature of the present invention is not the depth of the depression or generally what type of structure lies beneath the surface of the material, but rather that the surface of the material is ridge free.

The engraving 17 can be produced in numerous ways. As shown in FIGS. 1 and 2 the laser can be stationary and the surface to be engraved 15 can be mounted on a movable stage which is programmed to execute the movement necessary to trace out the desired pattern 17. Alternatively, the surface can be immobile, and the laser and associated focusing lenses can be moved. In many instances movement of such bulky structures is not feasible or rapid enough, so both the laser and the surface to be engraved are made immobile, and the laser beam is deflected by using a mirror 19 as shown in FIG. 3. The mirror can be of almost any material which will withstand the intense laser beam; such as polished stainless steel, front surface coated silicon, or front surface coated germanium. One suitable mirror is Model RT-00 made by Coherent Radiation Laboratories. A single mirror with two degrees of rotational freedom can be used so that the laser beam can be moved at will across the surface to be engraved. Alternatively, two mirrors with a single degree of rotational freedom apiece can be used, or a single mirror with a single degree of freedom can be used in conjunction with a moving sample stage. In short, almost any scanning device which will allow the laser to scan the whole surface of the plate is feasible.

Numerous methods can be used to produce the desired trace on the surface to be engraved. The simplest way would be to move the sample stage or laser, as described above, in response to some impulse to physically trace out the desired design. A second way would be to deflect the laser beam, by moving the mirrors, to physically trace out the required design. The mirrors could, for example, be mounted to follow the deflection of a ballistic galvometer. Such techniques would be suitable if the design to be traced on the sample plate were a simple design. It would be difficult, however, to reproduce a complicated design by such techniques. A more effective way to produce a complicated design, or picture, would be to scan the whole surface of the sample, or a portion of it, with the laser beam in much the same way that a television raster is produced. By modulating the laser beam as it scans the plate, depressions could be formed in the desired areas so that a predetermined trace or picture could be reproduced. Black and white images could be reproduced by cutting the beam on and off. Gradations could be reproduced by varying the intensity of the incident beam.

Modulation of the laser beam can be accomplished in a variety of ways. The output of the laser could be varied in much the same way that the electron beam in a television tube is modulated, so that in effect a picture could be engraved on the plate utilizing the same type of information that goes into a television receiving set. A simpler way to achieve the same result would be to keep the output of the laser constant and modulate the beam by placing a mask, 20, between the laser and the sample, as shown in FIG. 4. Some suitable imaging devices such as mirrors 14 and 21 would be required, but in any event the image engraved on the plate would correspond to the transparent areas of the mask. Such a mask can be either a template, with openings reproducing the desired image, or a filter where the intensity of the laser beam striking the sample is controlled by the optical density of the filter. To achieve high resolution such a mask would have to be placed in a focused portion of the beam, such as between mirrors 14 and 21 as illustrated in FIG. 4. Since the laser beam has the capacity to burn through many materials, such a mask would have to be constructed from material which would be effectively impervious to the laser beam during the period of its use. This places serious restriction on the type of material from which the mask can be made. Another way to use the laser to reproduce the image on a mask, be it either a template or a filter, would be to use an apparatus such as that shown in FIG. 5. In FIG. 5 the laser beam 13 strikes a semi-transparent mirror 22 placed in an unfocused portion of the beam. The semi-transparent mirror is constructed so that only a small portion of the beam 23 is deflected from the main path and the major portion of the beam 24 is available to be focused through lens 14 to be used in engraving the sample 15. The deflected portion of the laser beam 23 can be directed at the template 20, either directly or through deflecting mirrors, such as mirror 25. The light passing through the template is incident on a light detecting means 28, the output of which can be used to modulate the laser beam. This modulation can be accomplished by a feedback loop such as that indicated by lead 29. Alternatively the feedback loop can be connected to a chopping device, such as that discussed above in connection with FIG. 4, placed between the semi-transparent mirror 22 and lens 14. Light detecting means 28 can be a photocell or any other suitable device, and the components of the feedback circuit can be of any type known to those skilled in the art. Since the deflecting beam is unfocused, for high resolution, some sort of focusing system such as that provided by lens 26 and 27 is necessary. In this case, since only a small portion of the laser beam is being utilized, masks which would

ordinarily be destroyed by the full laser beam can be employed. As in FIG. 4 such a mask can be either a template or a filter, and in this case the filter can be a photographic transparency, where gradations in the opacity of the transparency are reproduced on the plate by gradations in the depth and/or diameter of the depressions. The template would be effective in the case of moderately simple black and white designs. A simple transparency would suffice for black and white photographs. Three or four transparencies would be required to produce the three or four printing plates required if color printing is contemplated.

All of the above techniques are applicable in the process of making printing plates by laser etching the surface of a material. It is conceivable that the printing plate be made from any material, such as a metal, or combination of materials, such as a coated metal, but the present invention relates to the production of polymeric printing plates. When a well focused high intensity laser beam is incident on a polymeric plate, a depression is formed in the plate. This depression has a cross section as shown in FIG. 6. The depression has a depth *a*, which is dependent upon the amount of energy supplied to that portion of the plate, and a width *b*, at the bottom of the depression, which relates to the diameter of the hottest portion of the beam. As noted above, the depression can extend all the way through the material, so that *a* is also determined by the thickness of the material and not only on the intensity of the beam. At the surface, the depression has a larger width *c*, which relates to the total diameter of the beam. Generally, the depression is formed by the process of melting and vaporization, so that a ridge is formed around the depression, extending a distance *d* above the surface of the plate, and extending a distance beyond the edge of the depression so that there is a total width *e* to the area of the material affected by the laser beam. This ridge is formed from the molten material by surface tension.

If the engraved material is to be used as a printing plate, the presence of the ridge renders the plate unacceptable because ink applied to the plate has a tendency to hang up on the ridges and blur or smear the printed image. In addition, if a picture or tightly spaced design is to be engraved, the molten material from one depression flows over into the neighboring depression, partially filling it, so that the resultant plate does not accurately reproduce the desired picture. Finally, a printing plate with well defined regular edges will produce sharper prints than a plate having rounded edges.

Ideally, the printing plate should have no ridges around the depressions. The plate should be smooth, except in the area of the depression which should have sharp regular edges. One way in which this can be achieved is to use a laser with high enough intensity to vaporize the plate material without melting it. While workable, this solution has several disadvantages. First of all the higher the intensity of the laser the higher the cost. Second, even if a laser with sufficient intensity to vaporize the material without melting it were used, it would be virtually impossible to vaporize the material without some melting on the periphery where the intensity of the beam is lower than it is in the center of the beam. Under the best of circumstances some rounding of the edges would occur. Finally, it would be virtually impossible to produce a plate with a variation in the depth of the depression corresponding to gradation in the picture to be reproduced by modulating the intensity of the incident beam. As soon as the intensity of the beam was decreased, melting would occur. To vary the depth of the depression, the scanning rate would have to be varied. This is at best a cumbersome technique.

There are some polymers, however, which appear to be in a class by themselves. Ridgeless depressions can be engraved in these polymers under conditions which will not cause the same type of depression in most other polymers. Delrin® Acetal resin, which is ether "end-capped" polyoxymethylene with a molecular weight above 10,000, is an example of such a polymer. In Table I the geometrical parameter of a depression etched in a plate made from "Delrin" is compared with the same parameters of holes drilled in plates made from the following materials: Lucite® 148 acrylic resin, which is a copolymer of less than 10% ethyl acrylate with methylmethacrylate; Zytel® 101 nylon resin, which is the copolymer poly(hexamethylene adipamide); Alathon® 34 polyethylene resin, which is polyethylene; and Teflon® FEP fluorocarbon resin, which is a copolymer of tetrafluoroethylene and hexafluoropropylene. The depressions were formed in each case by a Coherent Radiation Laboratory Model 40 CO_2 laser operated at 30 watts in the TEM_{00} mode for a 10 msec. pulse. The parameters are the same as those of FIG. 6.

TABLE I

	a	*b*	*c*	*d*
"Delrin"	0.025"	0.006"	0.010"	0
"Lucite"	0.030"	0.006"	0.012"	0.007"
"Zytel"			0.010"	0.028"
"Alathon"	0.010"	0.020"	0.011"	0.0012"
"Teflon" FEP	0.020"	0.008"	0.012"	0.0001"

As can be seen from column *d*, "Delrin" is the only material in the list with no ridge around the depression. All the rest have ridges significant enough to effect the clarity of a printed image.

A large number of other materials were laser engraved and evaluated as printing plates without actual measurement of the depression parameters. From among those tested, only the following appear to yield ridgeless depressions and function as effective printing plates: polychoral, hexafluoroacetone/formaldehyde, hexafluoroacetone/ethylene oxide, and polythiocarbonyl fluoride. It appears that the copolymer polychoral/p-chlorophenyl-isocyanate (95/5 mol percent) is also operable in the invention. These materials come from varied groups of polymers which include homopolymers of acetals, oxyalkylenes and aldehydes and copolymers containing substantial proportions of these monomers. Most of these polymers are long chained, having a backbone of carbon and oxygen emanating from a carbonyl bond of the monomer. Polythiocarbonyl fluoride, however, has a carbon-sulfur backbone emanating from a thiocarbonyl bond in the monomer. These polymers can be characterized as being solid homopolymers of a unit, or solid copolymers having a substantial number of units, of the general formula:

$$-\left(\begin{matrix} R_1 \\ | \\ C-X \\ | \\ R_2 \end{matrix}\right)_n-$$

where:

n is an integer having a value of at least one.

X is selected from the group consisting of oxygen and sulfur, and

R_1, R_2 are each selected from the group consisting of H, F, Cl, CF_3 and CCl_3. R_1 and R_2 can be identical. It should be noted that in some instances, specifically polyoxymethylene, the polymer may have to be "end capped" to produce a solid.

In addition to homopolymers and copolymers of materials selected from the group described above, it is to be expected that such polymers containing up to 5% of material that does not adversely affect the operability of the polymers used in the invention can be present. That is, at least 95% of the specified polymer in the surface would be expected to be successful in producing the results of this invention.

Materials which generally do not fall within the class of polymers discussed above have been found which also have the desired property of being amenable to the formation of ridgeless depressions. The "Zytel" listed in Table I for example, does not form the desired depression,

but if filled with between 20% and 50% by weight of fiber glass or rutile composition the plate can be engraved with a laser to form ridgeless depressions. The precise reason for this is not immediately apparent, but it can be theorized that in some situations, where the structure of the polymer from which the sample is composed is similar to but not identical to the structure described above, the addition of fillers, such as the rutile compositions and fiber glass mentioned above, which act as heat sinks, will localize heating to the point where localized melting followed by vaporization occurs.

What is claimed is:

1. A process for making a printing plate with a working surface substantially free from ridges which comprises:

(a) subjecting a plate, the surface of which is uniformly and substantially composed of a solid polymer selected from the group consisting of (a) homopolymers of a unit, and (b) copolymers having a substantial number of units, of the general formula:

where n is an integer having a value of at least one, X is selected from the group consisting of oxygen and sulfur, and R_1 and R_2 are each selected from the group consisting of H, Cl, F, CF_3 and CCl_3; to a focused beam of coherent radiation emerging from a laser having an intensity at least sufficient to decompose and form depressions in said surface;

(b) varying, in a controlled manner, the point at which the laser beam impinges upon said surface so that a predetermined pattern can be engraved in said surface; and

(c) controlling the intensity of the impinging laser beam in such manner that the size of the depressions can be selectively varied.

2. The process of claim 1 wherein said surface is uniformly composed of at least 95% by weight of the specified polymer.

3. The process of claim 1 wherein said polymer is polychoral.

4. The process of claim 1 wherein said polymer is a copolymer of hexafluoroacetone/formaldehyde.

5. The process of claim 1 wherein said polymer is a copolymer of hexafluoroacetone/ethylene oxide.

6. The process of claim 1 wherein said polymer is polythiocarbonyl fluoride.

7. A process for making a printing plate with a working surface substantially free from ridges which comprises:

(a) subjecting a plate, the surface of which is uniformly and substantially composed of ether "end capped" polyoxymethylene having a molecular weight greater than 10,000, to a focused beam of coherent radiation emerging from a laser having an intensity at least sufficient to decompose and form depressions in said surface;

(b) varying, in a controlled manner, the point at which the laser beam impinges upon said surface so that a predetermined pattern can be engraved in said surface; and

(c) controlling the intensity of the impinging laser beam in such manner that the size of the depressions can be selectively varied.

8. The process of claim 7 wherein said plate is mounted on a movable stage, and the point at which said laser beam impinges upon said surface is varied by moving the stage in a controlled manner.

9. The process of claim 7 wherein the laser is movably mounted, and the point at which said laser beam impinges upon said surface is varied by moving the laser in a controlled manner.

10. The process of claim 7 wherein both the laser and the plate are immovably mounted, and the point at which said laser beam impinges upon said surface is varied by deflecting the laser beam in a controlled manner.

11. The process of claim 7 wherein said laser beam is a pulsed laser beam and the depth of said depression is controlled by varying the duration, rate and intensity of the pulses incident upon said surface and the rate at which said laser beam moves relative to said plate.

12. The process of claim 11 wherein said laser beam is pulsed by periodically blocking said laser beam.

13. The process of claim 11 wherein said laser beam is pulsed by Q-switching the laser.

14. The process of claim 11 wherein said laser beam is pulsed by modulating the input to the laser.

15. The process of claim 7 wherein said laser beam is a continuous laser beam and the depth of said depression is controlled by varying the intensity of said laser beam and the rate at which said laser beam moves relative to said plate.

16. The process of claim 7 wherein: said laser beam is programmed to systematically traverse the whole, or a specified portion, of said plate; the pattern engraved on the surface of said plate is controlled by a template located between said laser and said plate; and the depth of said depressions is controlled by controlling the intensity of said laser beam and the rate at which said laser beam moves relative to said plate.

17. The process of claim 7 wherein said laser beam is programmed to systematically traverse the whole, or a specified portion, of said plate, and wherein the pattern engraved on the surface of said plate and the depth of said depressions is controlled by the optical density of at least one filter located between said laser and said plate.

18. The process of claim 17 wherein said filter is a transparency.

19. The process of claim 7 wherein:

(a) said laser beam is split into two unequal parts, the first part of said beam containing substantially all the energy contained in said laser beam, being program to systematically traverse the surface of said plate, and the second part of said laser beam being programmed to systematically traverse the surface of a mask in register with the movement of the first part of said laser beam;

(b) the pattern engraved on the surface of a plate by the first part of the laser beam is controlled by monitoring the intensity of the second part of the laser beam which passes through said mask, and using this monitored intensity to modulate the first part of said laser beam; and

(c) the depth of said depression is controlled by controlling the intensity of said laser beam and the rate at which said laser beam moves relative to said plate.

20. The process of claim 19 wherein the mask is a template.

21. The process of claim 19 wherein the mask is a photographic transparency.

22. A process for making a printing plate with a working surface substantially free from ridges which comprises:

(a) subjecting a plate, the surface of which is uniformly and substantially composed of a solid polymer filled with not less than 20% by weight or more than 50% by weight of rutile composition or fiber glass to a focused beam of coherent radiation emerging from a laser having an intensity at least sufficient to decompose and form depressions in said materials;

(b) varying, in a controlled manner, the point at which the laser beam impinges upon said surface so that a predetermined pattern can be engraved on said surface; and

(c) controlling the intensity of the impinging laser beam in such manner that the depth of the depressions can be selectively varied.

23. The process of claim 22 wherein said polymer is poly(hexamethylene adipamide).

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U.S. Cl. X.R.

101—401.1; 178—6.6; 264—80, 132, 293

PO-1050
(5/69)

UNITED STATES PATENT OFFICE.
CERTIFICATE OF CORRECTION

Patent No. 3,549,733 Dated December 22, 1970

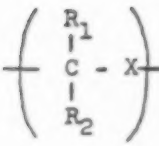
Inventor(s) Jack R. Caddell

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Abstract - column 1, line 18 and in Claim 1 - colume 7, line 21, the formula reading

" "

should read

--  --

Claim 19, column 8, lines 41 & 42, "program" should read --programmed--.

Signed and sealed this 20th day of April 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents

Plaintiff's Exhibit 29, Sales Brochure of Carco, Inc.

DATE

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LASERMARK

Boise Presto

Oignon

75

Defendant's Trial Exhibit 3, Brucker Patent No. 3,833,786

United States Patent [19]
Brucker

[11] **3,833,786**
[45] **Sept. 3, 1974**

[54] **LASER APPARATUS FOR FENESTRATION OF CONTACT LENSES**

[75] Inventor: **Donald Brucker**, San Diego, Calif.

[73] Assignee: **Continuous Curve Contact Lenses, Inc.**, San Diego, Calif.

[22] Filed: **June 8, 1973**

[21] Appl. No.: **368,193**

[52] U.S. Cl. ..... **219/121 L**, 51/216 LP, 269/21, 269/57, 269/58

[51] Int. Cl. **B23k 27/00**

[58] Field of Search ..... 219/121 L, 121 LM, 384; 51/216 LP, 284, 235; 269/21, 71, 57, 58

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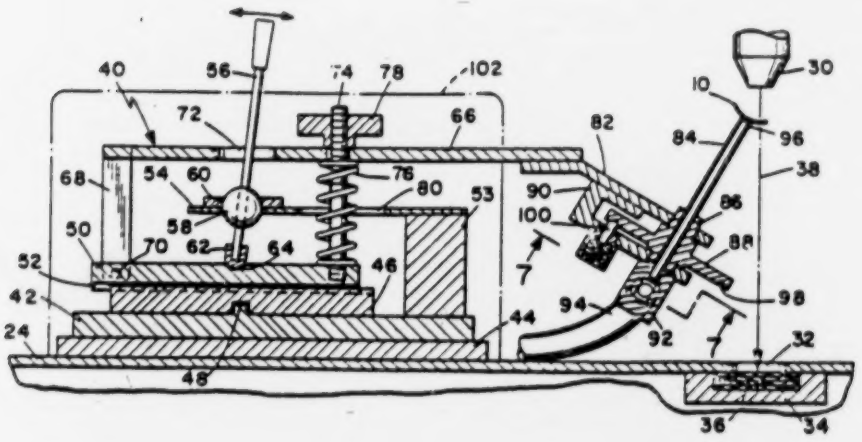
Primary Examiner—J. V. Truhe
Assistant Examiner—Clifford C. Shaw
Attorney, Agent, or Firm—Brown and Martin

[57] **ABSTRACT**

Laser apparatus for fenestration of contact lenses by forming consistently precise perforations being normal to the adjacent surfaces of the lens and with the inside diameter of the perforations being larger than the outside diameter; and having smooth and effectively polished surfaces. A lens is held by vacuum on a positioning mechanism, which is magnetically held on a base for coarse positioning, and incorporates two-axis stick controlled adjustment means for precise positioning of the lens relative to the laser beam. The lens support has indexing means for rotating the lens to a predetermined number of positions to space the perforations evenly adjacent the periphery of the lens.

5 Claims, 7 Drawing Figures



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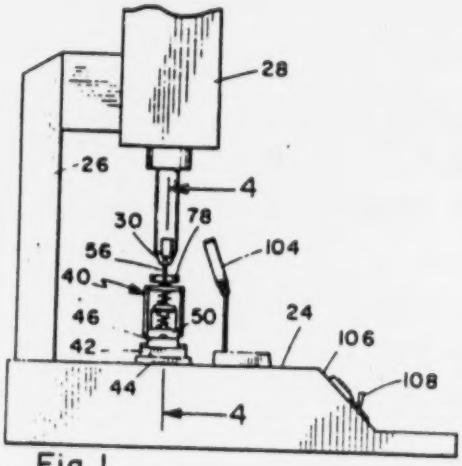

Fig. 1

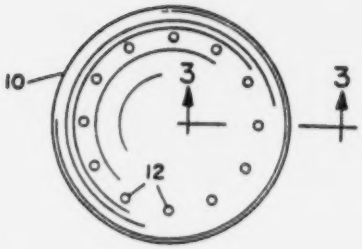

Fig. 2

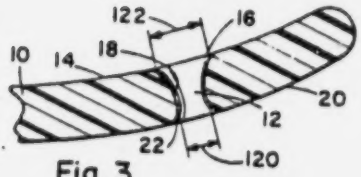

Fig. 3

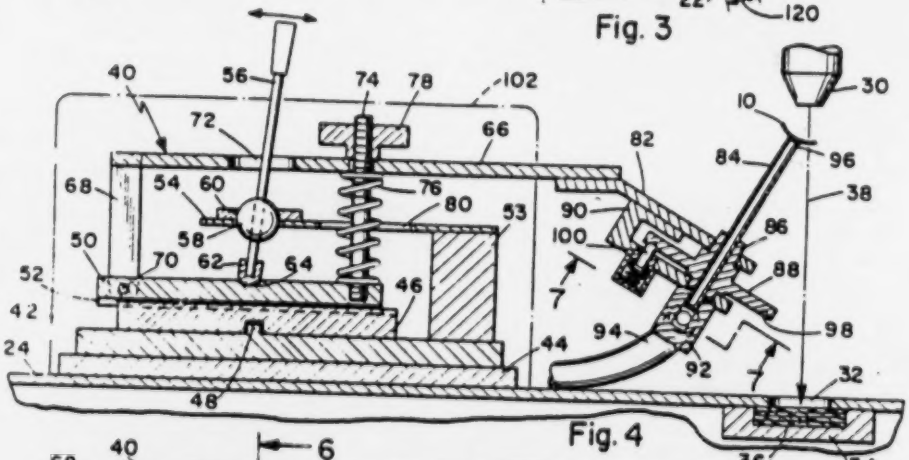

Fig. 4

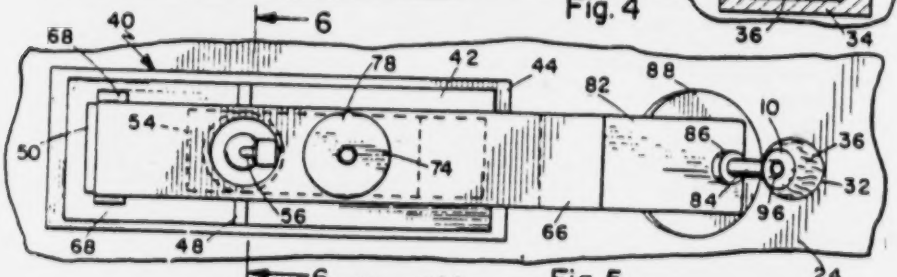

Fig. 5

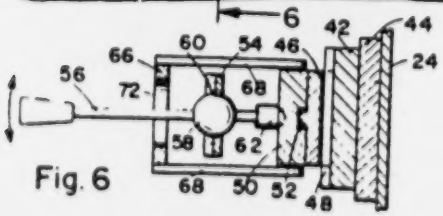

Fig. 6

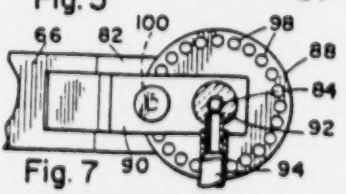

Fig. 7

LASER APPARATUS FOR FENESTRATION OF CONTACT LENSES

BACKGROUND OF THE INVENTION

Some people with sensitive eyes are unable to wear contact lenses for any length of time, if at all, due to irritation and corneal edema. The conditions can be relieved by proper circulation of pre-corneal fluid, which is a natural result of blinking. To avoid entrapment of fluid under a contact lens, the technique of fenestration has been applied, that is, one or more perforations are made in the lens. Blinking then causes a pumping action and circulation of fluid through the perforations, so providing lubrication and reducing the build-up of corneal edema.

However, attempts at fenestration have been generally unsatisfactory due to the extremely small size and materials from which contact lenses are made. With conventional drilling technique the perforations are rough and the edges are jagged, which can cause severe irritation. Since the perforations are normally a fraction of a millimeter in diameter, polishing of the edges is extremely difficult, and the risk of lens damage or breakage is considerable. To make fenestration practical, it is necessary to make precise perforations with very smooth surfaces and edges, without damaging the surrounding lens material and with a minimum of labor.

SUMMARY OF THE INVENTION

The apparatus described herein is capable of forming precisely positioned perforations of the desired venturi configuration in a contact lens, with surfaces and edges which have a polished quality without requiring additional work. The technique is particularly effective with lathe turned plastic lenses, but is also adaptable to other types. The perforations are made by a laser mounted in fixed position above a work base, to provide a focussed laser beam at a specific location. On the work base is a positioning mechanism held approximately in place by a magnet, and having fine control adjustment means for precise positioning of a lens holder relative to the laser beam. The lens holder is a tube on which the lens is held by a vacuum, with the peripheral portion extending beyond the tube. The holder is inclined so that the surface of the lens is substantially normal to the laser beam, in order to minimize the length of the penetration through the lens. Indexing means is used to rotate the lens holder for spacing perforations evenly at a predetermined number of peripheral positions. The fine adjustment means uses a single control stick for two-axis motion and also incorporates means for adjusting the height of the lens holder.

The venturi shaped holes with a larger opening on the inside surface of the lens, aid in creating a pumping action that with movement of the lens circulates the fluid underneath the lens and to the surface outside of the lens.

The primary object of this invention, therefore, is to provide a new and improved laser apparatus for fenestration of contact lenses.

Another object of this invention is to provide a new and improved laser apparatus capable of producing precisely positioned and smoothly finished perforations in a contact lens.

Another object of this invention is to provide a new and improved laser fenestration apparatus having mechanical means for precisely holding and positioning a lens at successive indexed positions relative to the laser beam.

A further object of this invention is to provide a new and improved laser fenestration apparatus which is simple to operate and requires a minimum of technical skill to produce a high quality fenestrated lens.

Other objects and many advantages of this invention will become more apparent upon a reading of the following detailed description and an examination of the drawing, wherein like reference numerals designate like parts throughout and in which:

FIG. 1 is a side elevation view of the apparatus.

FIG. 2 is an enlarged plan view of a typical contact lens with fenestration completed.

FIG. 3 is an enlarged sectional view taken on line 3—3 of FIG. 2.

FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 1.

FIG. 5 is a top plan view of the structure of FIG. 1.

FIG. 6 is a sectional view taken on line 6—6 of FIG. 5.

FIG. 7 is a sectional view taken on line 7—7 of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A typical lens produced by the apparatus is illustrated in FIGS. 2 and 3. The lens 10 has evenly spaced perforations 12 adjacent the periphery, twelve perforations being indicated as an example. The actual number of perforations will vary according to the size of the lens and the severity of the edema condition. Such lenses may be from about 7 to 10 mm in diameter, larger sizes being used by some athletes, or for certain optical conditions such as aphakia or de-centered pupils.

The perforations should not be so close to the edge as to cause structural weakness, nor too close to the center where they would interfere with vision. Also, the diameter of the perforations should be as small as possible, while allowing adequate fluid flow without undue danger of becoming obstructed. It has been found that perforations on the order of 0.2 mm in diameter are ideal.

The use of a laser results in a finished perforation, as in FIG. 3. The intense heat of the laser initially striking the concave or posterior surface 14 forms a flared entry portion 16, converging to the optimum diameter bore 18. At the convex or anterior surface 20, the emerging laser beam flares the edge slightly into a rounded exit 22. It has been found that the entire surface of the bore and the flared portions have a finish comparable to a fire polish, and no further finishing is necessary.

This provides a hole shape that is larger on the inside surface than on the outside, creating a venturi shape. This shape functions to pump the fluid through the holes 12, thus increasing the circulation of the fluid underneath the lens to the outside. Through the mechanism of blinking, a pumping action results that forces fluid out through the holes and thereby draws fresh fluid underneath the lens. This is a very efficient way of improving pre-corneal circulation under the lens with all the additional advantages that such circulation

provides, and also increases tear and gas exchange. The drilling of the holes through the lens does not affect the characteristics of the lens, which remains essentially the unchanged.

The smallest diameter 120 of each of the holes is about 0.2 mm. The 0.2 mm size allows a reasonable fluid flow through each hole as the diameter is large enough to over come the tendency of surface tension of the pre-corneal fluid to impede passage. Also, the holes have the larger inner diameter 122 opening 16, that may be in the order of 0.3 mm that with the smooth surfaces provides volume gathering of fluid in increased pressure discharge through opening 12. Further there is less turbulence in fluid flow because of the venturi action, and there is less optical interference by the holes because the smaller diameter opening is at the outer surface of the lens where most of the refraction occurs.

The laser apparatus is mounted on a base housing 24, which contains the controls and serves as a work table. A post 26 on the rear of housing 24 supports the laser 28 in a vertical position, with the focussing tip 30 directed downwardly. The power supply and associated support equipment, not shown, will depend on the type of laser use, and is conventional. In the housing directly below the laser is an opening 32, under which is a heat sink 34 containing an asbestos pad 36, or the like, to absorb the residual energy of the laser beam 38.

The lens is held on a positioning mechanism, generally indicated at 40, the mechanism having a base plate 42 which is held on housing 24 by a magnet 44. The magnet facilitates approximate location of the mechanism to suit the operator. On top of base plate 42 is a lateral slide block 46, guided in sliding motion by a key 48. On the lateral slide block is a longitudinal slide block 50, guided by a key 52 perpendicular to key 48. Any suitable orthogonal slide or guide means may be used to provide two axis horizontal motion of the slide block 50, to which the lens mounting is attached.

Fixed to base plate 42 is a post 53, on top of which is a leaf spring arm 54 extending over the slide block structure. Mounted on spring arm 54 is a control stick 56, having a ball element 58 which is held in a socket 60 on the arm for free pivotal movement of the stick. On the lower end of control stick 56 is a ball pad 62 which seats in a socket 64 in slide block 50. The spring arm 54 holds the slide block assembly firmly on base plate 42, but allows two axis motion of slide block 50 by motion of the control stick, as indicated by directional arrows in FIGS. 4 and 6.

Above the spring arm 54 is a longitudinally extending support arm 66, having downwardly projecting legs 68 at one end. The legs 68 are attached by a hinge pin 70 to the slide block 50 at the end remote from post 53, so that the support arm can swing vertically. Control stick 56 projects upwardly through a clearance opening 72 in support arm 66. Fixed in slide block 50, at the opposite end from hinge pin 70, is an adjustment screw 74 which extends upwardly through support arm 66. A spring 76 fitted over screw 74 biases the support arm 66 upwardly and a knob 78 threaded on the screw above the support arm allows vertical adjustment of the arm. Spring arm 54 has a clearance opening 80 for the screw 74 and spring 76.

On the free end of support arm 66 is a downwardly inclined extension arm 82, which carries the lens supporting stem 84. The stem is a thin tube having a diameter substantially less than that of the smallest lens to be held. Stem 84 is mounted in the hub 86 of an indexing disc 88, which is rotatably mounted in extension arm 82 and supported in a bracket 90. The lower end of stem 84 fits into a connector 92, from which a hose 94 leads to a suitable source of vacuum, not shown. The upper end of stem 84 forms a seat 96, on which lens 10 is held by vacuum, the stem being inclined to vertical to hold the lens in the path of the laser beam 38, leaving a clear path for the beam below the lens, as in FIG. 4. In the underside of indexing disc 88 are peripherally spaced indexing sockets 98, which are selectively engaged by a spring loaded detent pin 100 mounted in bracket 90. As illustrated, the indexing disc has 24 sockets which allow the lens to be rotated to 1,2,3,4,6,8,12, or 24 evenly spaced positions. Any suitable number of indexing sockets may be used, either in a single ring or in multiple concentric rings with appropriate detents.

In setting up the apparatus, the positioning mechanism 40 is placed at a convenient position for the operator and held by magnet 44, the seat 96 of the lens holding stem being near the laser beam location. A cover 102 of any suitable type may be fitted over the mechanism, as indicated in broken line in FIG. 4, to protect the mechanism and provide a rest for the operator's hand in moving the control stick. A lens 10 is placed on seat 96 and centered, the small size making it practical to align the lens by eye against the ring of the seat, as seen in FIG. 5. For final alignment, the lens is adjusted by means of control stick 56, to position the peripheral protion of the lens in the path of the laser beam. To assist in the alignment, a suitable stand mounted magnifier 104 may be placed on housing 24 for the operator to view the lens. A laser beam position reference is used to align the lens precisely. The reference may be provided by operating the laser at a low power setting, or by a reference light source incorporated in the laser optics, the technique being well known. Knob 78 is used to adjust the height of the lens to the focal point of the laser beam for efficiency and uniformity of perforation.

For convenience, the housing 24 has a control panel 106, on which are the necessary controls for power supply, laser support equipment and the laser firing control. With a laser of suitable power, a single short pulse is sufficient to make each perforation, the lens being indexed to the required position after each laser action to obtain the predetermined number of perforations. Since the fenestration is completed by the laser, the only skill involved is in positioning the lens, which is easily learned. Completed lenses need only conventional cleaning before being ready for use.

Having described my invention, I now claim:

1. Laser apparatus for fenestration of contact lenses, comprising:

a housing;

a laser mounted on and having its beam path directed toward said housing;

said mechanism having a lens holder with a seat for holding a lens thereon, with the peripheral portion of the lens extending into the path of the laser beam;

indexing means on said lens holder for rotatably indexing the lens to predetermined peripheral positions relative to the laser beam.

said positioning mechanism includes a base plate and a slide block mounted on said base plate for motion in at least one direction, said lens holder being secured to said slide block,

said slide block is movable in two orthogonal directions,

control means coupled to said slide block for selective movement thereof,

a spring arm mounted on said base plate,

and said control means comprising a stick pivotally mounted on said spring arm and having an end portion biased into pivotal engagement with said slide block.

2. Apparatus according to claim 1, and including a support arm extending from said slide block, said lens holder being mounted on one end of the support arm; and means for adjusting said support arm to move the lens holder substantially along the path of the laser beam.

3. Apparatus according to claim 2, wherein said lens holder comprises a hollow stem with said seat on one end thereof, the other end of said stem having means for connection to a source of vacuum.

4. Apparatus according to claim 3, wherein said stem is inclined with the seat end thereof extending toward the laser beam path.

5. Apparatus according to claim 4, wherein said seat is substantially smaller than the lens, the inclination of said stem being such that the peripheral portion of the lens intersecting the path of the laser beam is substantially normal to the beam.

* * * * *

Excerpt of Plaintiff's Proposed Findings of Fact and Conclusions of Law Under Local Rule 235-8, pp. 1, 21, 22

APPEAL NO. 85-2578

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UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF CALIFORNIA

No. C-83-20283-RPA

BAUSCH & LOMB INCORPORATED, a corporation,
Plaintiff,

v.

BARNES-HIND/HYDROCURVE, INC., a corporation, and BARNES-HIND INTERNATIONAL, INC., a corporation,
Defendants.

Excerpts of Plaintiff's Proposed Findings of Fact and Conclusions of Law Under Local Rule 235-8, pp. 1, 21, 22

PLAINTIFF'S PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW UNDER LOCAL RULE 235-8

Plaintiff Bausch & Lomb Incorporated submits the following proposed findings of fact and conclusions of law pursuant to Local Rule 235-8.

* * *

Secondary Considerations

(76) Defendants' laser marked lenses are virtually identical to those of Plaintiff and are produced by the same laser marking process copied by Mr. Jakoski from the Milton-Roy facility which made lenses in accordance with the invention of the '814 patent as claimed in claims 1, 2 and 7.

(77) Prior to the invention of the '814 patent, Dr. Brucker claims to have used a laser to mark contact lenses in conjunction with his LASER-CON process of fenestrating hard contact lenses. No documentary evidence has been offered by Defendants to corroborate these claims. In any event, even though Dr. Brucker apparently had the invention right under his nose, neither he nor Continuous Curve found it obvious enough to discover at the time and, instead, ended up copying the patented invention.

(78) Persons interested in the subject of marking toric contact lenses, such as Dr. Brucker and Mr. Jakowski, failed to succeed in developing the patented invention despite the recognized need for a better marking technique.

Excerpts of Plaintiff's Proposed Findings of Fact and Conclusions of Law Under Local Rule 235-8, pp. 1, 21, 22

(79) Plaintiff's and Defendants' laser marked toric soft lenses have been widely adopted and used by eye care professionals as a replacement for the previous mechanically marked lenses. In view of the commercial success of these lenses, they have been nationally marketed and advertised.

(80) To attempt to invalidate the '814 patent, Defendants are relying upon prior art which is the same as the Brucker and Caddell patents cited by the Examiner.

II. CONCLUSIONS OF LAW

* * *

Bausch & Lomb Reply Brief on Appeal to Federal Circuit, p. 22

REPLY BRIEF FOR APPELLANT

UNITED STATES COURT OF APPEALS

FOR THE FEDERAL CIRCUIT

APPEAL NO. 85-2578

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* * *

Barnes-Hind's brief, at page 31, makes the point that "There Was No Commercial Success." Because Bausch & Lomb is not relying on commercial success on this appeal, Barnes-Hind's argument is irrelevant.

* * *